RAILROAD GAZETTE

SATURDAY, APRIL 11, 1874.

Latimer's Safety Guard for Railroad Bridges.

We illustrate herewith an improvement intended to provide a bridge, curve or other place on a railroad track where there is danger of the wheels of a truck running off the track, with a means of replacing them, and at the same time preventing them from moving so far from the rails as to pass over the end of the ties or sides of a bridge.

Fig. 1 is a plan view of a device embodying the elements of the invention. Fig. 2 is a perspective view of the same, showing the inclination of the lifters. Fig. 3 is a vertical transverse section through the line *x x*. Fig. 4 is a similar view through the line *z z*. Fig. 5 is a side elevation with certain parts broken out.

The truck of a car running off the track *A* is guided by the contact of the wheels with the guide-rail *D* and guides *C* until they reach the inclines at the end of the lifters *E* and *F*, up which they ride, being directed on each side toward the rails, the wheels outside the track running upon the top of the lifter *F*, while the flanges of the other wheels, being in contact with the guide *C* or lifter *E*, draw the opposite wheels constantly toward the track until the obtuse angle of the platform *B* is reached, when the flange of the opposite wheel is drawn over the rail and drops into the channel between the lifter *E* and the rail, while the other wheels pass at once upon their rail, thus replacing the car on the track.

A number of these guards have been placed on Western roads, and the General Manager of one of the roads where the guards have been used writes that at one bridge "they have saved two passenger trains from going into the river by bringing them back upon the track after they were derailed, probably saving the draw-bridge, if not more." Mr. C. Latimer, of Meadsville, Pa., is the inventor.

FIG 1

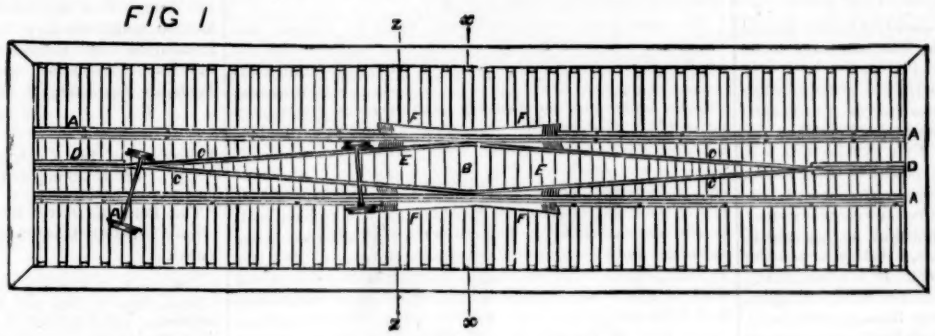


FIG. 2

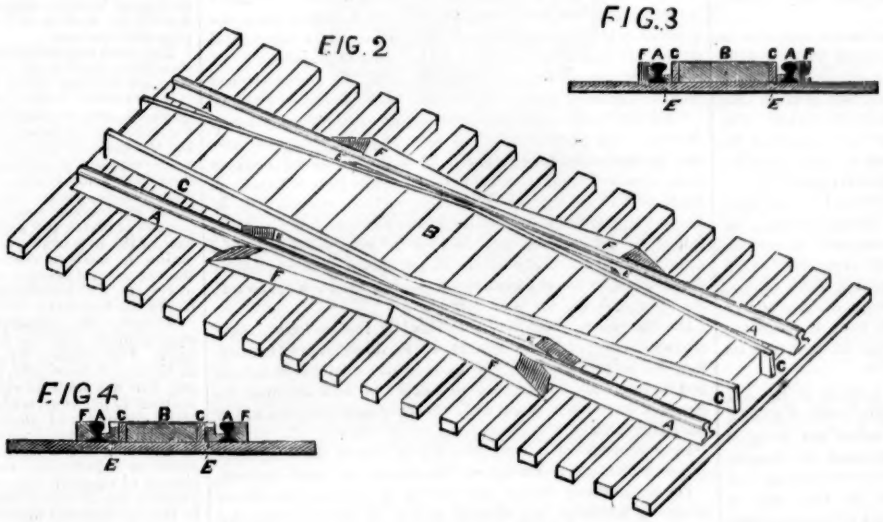


FIG. 3

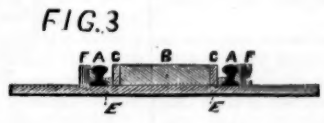
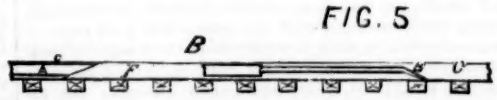


FIG 4

FIG. 5



LATIMER'S SAFETY GUARD FOR RAILROAD BRIDGES.

Prices of Rails in March.

Bigelow & Johnston report foreign iron at $55 to $58 gold; American iron $60 to $65 currency; foreign steel $98 to $100 gold; American steel $97½ to $100 currency. There were no imports of foreign iro at New York in March, as there have been none this year. Of steel, the New York importations were 6,219 tons in April. For the first quarter the imports at New York were 15,905 tons of steel, against 16,146 tons of steel and 17,381 of iron in 1873.

Old rails are quoted at $39 to $40 for T or flange. Only 65 tons have been imported at New York this year, against 3,389 in 1873. The firm say in their monthly circular:

"*New Rails.* — But little improvement, if any, can be noted during the month. The low price at which American rails can be bought interferes with the sale of foreign, except where an occasional transaction is made 'in bond.' In American rails some little business has been done on private terms, but there is a great dearth of *safe* orders. The inquiries are numerous, but the terms offered by buyers are usually on long periods of credit which the makers do not feel justified in according. Where buyers will pay cash a liberal concession can be obtained from sellers. The English market is depressed and prices have declined, but there is no immediate prospect of shipments to this country.

"*Old Rails.*—Very little has been done in imported rails. A few hundred tons T section were sold for consumption at about our quotations on time with interest. Nearly 1,000 tons bridge pattern have been taken on speculation at $39 cash in 30 days, a very high figure for that kind of rail. The European market is lower and will soon admit of shipments hither."

The Value of Suggestions.

APRIL 4, 1874.

TO THE EDITOR OF THE RAILROAD GAZETTE:

It may be a matter of interest to you to know that one more of your subscribers has found, in the brief discussion about errors in leveling contained in the last two numbers of the GAZETTE, the explanation of difficulties, or slight inaccuracies, which puzzled himself and every other engineer in a large corps engaged on a Western railroad for *two years*. Your subscriber was running the levels, under the best conditions for equal fore and back sights, taking the utmost pains to make the work check; but slight errors appeared, and were the subject of discussion at different times among eight or ten educated and experienced engineers, and some experienced engineers who were not educated, and not one among them ever knew or thought of the manifestly sufficient remedy of waving the rod back and forth on turning points. I say, then, that it does not follow, as has been intimated, that "N" was "not an experienced operator" because he has proposed a somewhat unpractical remedy. It may show that he, like many others, does not possess the genius to learn without being informed by others more experienced than himself. I trust he is glad to be instructed by means of the GAZETTE.

[Entered according to Act of Congress, in the year 1874, by the RAILROAD GAZETTE, in the office of the Librarian of Congress, at Washington.]

Comparison of the Merits of the Mode of Building Iron Truss Bridges in America with the System Used in Europe.

BY CHARLES RENDER, C. E.

The progress of the manufacture of iron and of mechanical and railroad engineering within a small number of years has resulted in the development of the numerous systems of bridges which are now used. It was necessity that gave the great impulse in this direction, and though nearly all of the general systems and also quite a number of essential details used in the present structures had been used or at least been recommended by earlier writers, yet their ideas had to be reinvented, Europe and America interchanging their improvements.

At the beginning of wrought-iron bridge-building, Europe, not far enough advanced for the correct construction of iron arch bridges, turned her eyes to the wooden trusses developed meanwhile by the Americans, and proceeded to build the systems of Town, Long, Pratt and Howe in iron, while America continued until lately to use wooden bridges almost exclusively for her great net of railways.

And when the necessity had arrived to replace these perishable wooden structures by durable iron bridges, America had the opportunity of using the experience and a number of essential details which meanwhile had been tried by European practice.

In the selection of these details, and in their application to their wants, the American engineers have shown a great deal of practical tact; and within a few years they have produced a system which by appearance, by simplicity, solidity and economy is favorably distinguished from the system used in Europe.

This with most of its details has been worked out in England, where the abundance of cheap material has inclined it to a system in which can readily be recognized the principle to build exclusively of angles and plates, and, if possible, to use the rolled bars in the same shape as furnished by the mills. The Americans have not limited themselves by such a rule, but are governed by the broader business principle, to apply that construction by which the technical purpose can be carried out with the least quantity of total labor, all factors being considered.

It is made the subject of the present paper to show how they have done this, and by what proportions and in what details their designs differ from European arrangements.

Of course reference is made only to those structures which leading American firms, with almost congruous details, are in the habit of erecting, whose study would soon disperse those prejudices which have been created in Europe on account of disasters which were caused by insufficiently experienced builders. Similar disasters have also happened in Europe, and their number was less, not on account of the superiority of her systems, but principally on account of the strict governmental supervision, which in the United States, on account of her public institutions, has not been introduced.

The differences between the two systems can be found to consist in the degree of excellency of the applied general arrangement; in the use of the proper proportions between length and depth of span and the length of panels; in the form, character and strains of the applied metal; in the mode of forming connections; in the application of castings, and in the manner of erection.

Each of these points in the following will receive some consideration.

The general systems of American truss bridges, when compared with those used in Europe, are striking by their simplicity. It may be said that of all the different forms there are two which excel all others, and are bound to be used exclusively in the future. These trusses have parallel chords, and either vertical or inclined web-posts. The trusses with vertical posts and inclined tie-bars are called "Pratt or Whipple" trusses, and may have vertical or inclined end-posts, and single, double, or more fold intersections of diagonals. The others are Neville or Warren trusses, posts and diagonals being inclined either at equal angles, or the posts may be inclined differently from the ties. In point of economy, when all circumstances are fairly considered, the quadrangular or Pratt truss seems to afford the greatest advantages, from the reasons that it can be built higher, that it can be manufactured and erected somewhat more easily, and that the cross-bearers can be more substantially attached to the posts than is the case when the posts are inclined.

Since these truss bridges are built so that each tensile member can articulate around the theoretical points of intersection of the center lines, the suppositions of the theory are almost strictly carried out. This is not the case with the European riveted structures, for each part of these bridges will receive a moment of flexure at the points of connection, and the theoretical center lines mostly do not intersect in one point, around which free turning motions should take place. Though it is possible to prove that these moments of flexure are not large when compared with the total moment of the bridge, they nevertheless will affect the rivet connections and add strains in certain points, which accumulate to 30 per cent. and more of the calculated strains. This is a very considerable increase, equivalent to an addition to the load of 30 per cent. The effect of this and other irregularities probably can only be shown after the use of such structures during a greater number of years, and will certainly shorten their life-time. The simple American structures are free from such objection.

Again, the majority of European bridges are built on the now antiquated lattice plan, according to which all systems of diagonals are connected with each other by rivets at the points of intersection. Of course, it is totally impossible to calculate with any degree of correctness the strain in any of these members, nor is it possible to state what is the exact strain in a chord, because the web system takes up a part of the moments.

The American structures mentioned, on the contrary, are arranged in such a manner that each system of ties and posts is totally independent of the other. This is strictly true for single trianguiar trusses and for quadrangular trusses with vertical end-posts, while for Pratt trusses, with a double system of diagonals and posts and with inclined end-posts, the connection of both systems takes place only at the end top joints, where the influence of this deviation is less than that caused by the value of one panel load divided by the number of panels of the bridge.

These being the differences concerning the general systems of European truss bridges when constructed with parallel chords and open web systems, there are still very great points in favor of the general systems of American bridges when compared with European trusses with chords not parallel, not to speak of the antiquated tubular or the plate bridges.

Let us compare for a moment the action of a parabolic girder with that of a truss with parallel chords. The web of a parabolic girder under full load is inactive, and its office must be done by the curved chords, while the web of a Neville or of a Pratt truss under uniform and full load is almost fully in action. The parabolic girder is arranged so that only under a certain condition is the web active. The maxima web strains are but small, and this must lead to a considerable amount of web metal when compared with its office.

The trusses with parallel chords lose a comparatively far smaller amount of metal in the web systems. The parabolic truss, or any other with curved chords, loses always a considerable amount of material by the increase of the chord sections, and this loss is not made good by saving in the web. Professor Culmann, in Zurich, has proved theoretically that here is a remarkable difference in favor of the trusses with

parallel chords, and experienced practical bridge-builders will indorse his result. For a large span with one curved chord, under the supposition of proper lateral bracing in top and bottom surfaces, the difference in cost and value may not be so very great, because it is easier to build the web system without material loss of metal, though extra cost of workmanship and an additional quantity of chord material must still be expected; but when we turn to analyze trusses with two curved chords, or with but one lateral bracing in the bottom floor, we will have to do with structures far inferior to any good truss with parallel chords. This is the fact, from three reasons: namely, because of the increased difficulty of manufacture; then from the necessity of forming a straight floor surface, which can only be accomplished by another addition of metal; and finally, because of the deficiency of lateral stiffness of the top chords.

Curved top chords without lateral connections must be considered as pillars, being as long as the whole span, which can bend out laterally.

These chords consequently should be very wide and stiff, and should contain more material than is generally the case. The stiffening knees, which in most cases are attached to cross-bearers and posts, are expensive, and their efficiency can merely be guessed at. Such a top chord should always be built continuously. The parabolic or similarly formed chords without proper lateral bracing are therefore of inferior strength when compared with straight and parallel chords; they require more iron, and their workmanship is more expensive and less trustworthy.

Bridges with curved top and bottom chords of course are still less economical, since also a straight floor will have to be formed, with the expense of material and labor.

When the great expense connected with such structures has been proved, their alleged beautiful lines are generally recommended. But how can a structure be called beautiful if, as is the case with the bridge across the Elbe River at Hamburg, it is obvious that its arrangements are not appropriate to the wants, while even professional men cannot detect any sufficient reason to warrant the deviation from approved and simpler forms?

In order to give an example to show that no material is gained by the adoption of curved chords, a bridge across the Brahe River in Prussia can be mentioned. It is a bow-string truss, 81 feet long and 10 feet deep, praised as being very light, with 752 pounds per lineal foot, while a through Pratt truss for the same rolling load could have been built more than 20 per cent. lighter, causing considerably less labor for manufacture and erection.

As another example for comparison, the 210 foot trusses with curved top-chords of the Elbe bridge on the Berlin-Lehrte Railroad may be quoted. It is a double-track bridge designed for a rolling load of 2,450 pounds per lineal foot of track, the strain being 11,000 pounds per square inch of section. The iron of this structure (depth of truss being one-seventh of the span) weighed 1,360 pounds per lineal foot, so that a single-track bridge would have had about 1,570 pounds per foot.

The Pratt trusses of over 200 feet on the Grand Trunk Railway of Canada, built by the Phœnixville Bridge Works, are designed for 3,000 lbs. per lineal foot, are strained in the average to only about 9,000 lbs. per square inch, and weigh over 25 per cent. less than the much weaker Elbe bridge. Certainly there must exist valuable advantages in favor of this bridge built by American engineers, which have induced the Canadian Government to introduce this style of structure on their road.

Finally, when we consider how slow and tedious is the calculation and the designing of bridges with curved chords, while the calculation of forces, sections, weights and price of an American bridge requires but some hours, and the designing part only a few days, we shall arrive at the conclusion that the few principles of the theory form by far the least part of the knowledge of a bridge-builder, but that it is far more difficult to design proper details and to become familiar with the amount of labor, with the weights, prices and other experience. It requires many years to study the material, detail arrangements and the erection of bridges, but it takes only about as many days to learn the really valuable points of the theory of the general arrangement of bridges.

Now a few words more must be added concerning continuous bridges.

These are still favored by many European engineers, who hope thereby to save a part of the material.

The writer of these lines himself had for some time thought that it might be possible, by application of pin joints, by reducing the number of parts, by the use of proper scales and adjustments for the regulation of the pressures on the three or more piers of a continuous bridge, and by the use of scientifically correct and complete formulæ, to produce reliable continuous trusses, by means of which the large rivers of this country could be spanned without the use of false works.

The writer, with a great deal of labor, had constructed an analytical expression, which embraced the relation of the moments of flexure over three consecutive piers of a continuous girder. In this formula due attention was given not only to the deflections caused by the chords, but also to those due to the tensile and compressive members of the web system. In this formula was introduced the actual section of each separate member. It therefore did away with two errors of the formulæ generally quoted in books, which are only applicable when the girders are very shallow and when the web is a plate, and which even under those suppositions do *not* coincide very satisfactorily with experiments.

Notwithstanding the theoretical improvements mentioned, it was finally found that the labor spent in finding said formula had been in vain, from a reason which in Europe, as far as known, has not received any consideration. It is the great variability of the modulus of elasticity, which in the formulæ of the books is supposed to be a constant value of about 25,000,000 pounds per square inch.

But the writer has tested during his presence at the Phœnix Iron Works many thousands of eye-bars, made for actual use in bridges, and he has found that the modulus of these members is very changeable, namely from 18,000,000 to over 40,800,000 pounds per square inch, so that small sections give the lowest and large sections the greatest figures. The same result was obtained by the Canadian engineer, who inspected the iron for the International Bridge near Buffalo, as well as by Mr. B. Nicholson, who was sent to Phœnixville by the government officers of the United States to inspect the iron for the Mississippi Bridge at Rock Island.

The figures obtained for bars of the same section and lot, however, were remarkably uniform.

This result proves that to the objections against continuous girder bridges one must be added which cannot be overcome by calculation, nor by manufacture, and that consequently the strains of such bridges are always uncertain, if at least the same section is not used throughout the whole bridge.

Of course the modulus of riveted work is still less reliable than that of eye-bars, and hus we see that the supposition of a uniform modulus of elasticity on which the whole edifice of the extended theory of continuous girders is built, must be considered as utterly incorrect, and the conclusions drawn from such supposition must be refused.

Moreover no material is gained by the principle of continuity when large spans are built high enough, for in this case whatever material can be saved in the chords will be entirely lost in the web system, while small spans should not be crossed by continuous bridges at all.

The same result will be obtained when we compare the weights of well-built European continuous bridges with the weights of large single spans designed on the American plan.

For this purpose the dimensions and weights of the great Russian Bridge over the Dnieper River at Krementszug may be quoted. This structure consists of a number of double-track continuous lattice girders over pairs of openings of 387 feet each, and was designed by Professor Sternberg, of Karlsruhe in Germany, for a rolling load of 2,660 pounds per lineal foot of track and for strains of 9,800 lbs. per square inch, both tensile and compressive. The iron work of this bridge, being one of the finest specimens of the kind and designed with the greatest possible economy, weighs 2,300 pounds per foot and track, so that a single-track bridge would have weighed at least 2,700 pounds per foot. An experienced bridge engineer knows that he can obtain with single-span trusses equally small weights under application of the American system of bridging, the life loads and the tensional strains being the same as in the Krementszug bridge, while the compressible strains are varied according to the length and diameter.

We now proceed to the consideration of the proportions of length of span to depth of truss, and of the lengths of panels.

Until lately almost all European bridges were arranged very shallow. The plate girders and tubular girders were the lowest, the lattice bridges followed in height, and by degrees were arranged simpler and also higher. The firm of Kramer & Klett, in Nuremberg, who had improved on the fish-belly or Laves-Pauly truss nearly as far as was possible under application of riveted connections, could use the greatest depths, and could apply at the bridge of Mainz a standard of good proportions which, as far as known to the writer, for such spans and such purposes has not been surpassed.

On the whole, however, American engineers build their trusses deeper, and they can afford to do so, simply because they use better forms of compressional and tensional members, and therefore are not limited in height of web by rapid increase of its weights, much as is the case under application of the lattice plan.

In close connection with the depth stands the length of panels, which also in Europe on the average are made shorter.

The Kuilemburg bridge has panels of 13⅓ feet, the Rhine bridge at Manheim has already panels of 15 feet. This is a good length, but has been surpassed already in America by building quadrangular trusses with panels of 17 to 20 feet.

It is plain that by such an arrangement the number of parts is diminished and workmanship is reduced, while at the same time the weights of cross-bearers and stringers are increased.

But this is a great advantage, for these long beams not only are more elastic, but also are heavy and bring more material in the right place, namely, where it will be directly opposed to the life load.

The greater depths of American trusses diminish the deflections, which by General Morris are fixed between the limits of 1-600 to 1-800 of the span, while American practice has reduced them to just about one-half of these amounts.

The longer panels of well-built American bridges and the great cubic contents of heavy and long track ties and guard rails arranged in connection with such floors, certainly remove any objection which could be derived from a high degree of vertical stiffness, while the small deflection, on the other hand, will reduce additional strains arising from centrifugal force, if the proper camber of the floor should not have been obtained.

A few examples of the influence of great speed on deflections, and, therefore, also on the strains of bridges, may find a place here.

The Rhine bridge at Mainz has spans of 344 feet, the depth being 1-7th of the length.

A freight train of 296 tons under a speed of 4 miles an hour caused a deflection of .....1.931 inches
Speed of 25 miles an hour caused a deflection of.....1.988 "

Therefore, the increase of strain by the increase in speed amounted to 2⅛ per cent., while the Cologne bridge over the Rhine River, with a depth of 1-11.6 of the span, showed an increase of 3⅛ per cent., and would have had 4¼ per cent. if it were not constructed on the continuous plan.

Some spans of the bridges on the Cologne-Giessen Railroad showed increases of strains and deflections equal to 8 per cent., when the trains passed at high speed, over those strains and deflections obtained by the same but static loads.

An article in the *Annales des Ponts et Chaussees* of the year 1861 fixes the increase of strains due to increased deflections under quick passing loads to 10 per cent., while for well-designed deep American structures an increase not exceeding that of the Mainz bridge can justly be expected.

The immediate action of the engine and cars on the iron can be counteracted very effectively and very economically by placing long and heavy wooden ties and guard rails between rails and bridge, and this wood by its great volume and small modulus of elasticity is the proper material to answer the purpose of checking the consequences of a derailment.

The mode of neutralizing the effect of impacts on well-designed American iron bridges, therefore, consists especially in the *proper design in general*, while English engineers have suggested and have used for this purpose heavy ballast of stone and gravel, and lately endeavor to excuse the waste of material of their system on the same score.

If we need stronger bridges than those which are built at present, this task must be accomplished by the use of the most rational and most economical system in combination with a moving load greater than that specified at present, but certainly not by reducing the strength of the structure under the load of waste metal.

The effect of this kind of medicine would be precisely the same as that of building the bridge on the safest and most economical plan, but of finally putting the material saved on the bridge floor, say in the shape of scrap iron, and this method would still have that preference over the one recommended by some English engineers of being the cheaper of the two. — *Translated from the Zeitschrift des Vereins Deutscher Ingenieure of Berlin.*

[TO BE CONTINUED.]

A Letter on the Comparative Merits of Pin and Riveted Connections in Bridge Building.

The following letter by Mr. W. W. Evans, C. E., has been printed privately heretofore, but is now, we believe, first published:

NEW YORK, Oct. 17, 1872.

*To Major A. T. S., Chief Engineer * * * Railway:*

DEAR SIR.—I sent you by last mail some notes on bridge-building. I now propose to write some more, on a comparison between "lattice" and other forms of bridges, where the parts are connected by riveting, and the "Phœnixville" and other designs of bridges, where the compression members are connected by sockets and tenons, and the tensile members by pins and eye bars.

The most important qualities of iron bridges are strength, durability, facility of erection and cost. It is proposed to compare the two styles of construction, which will be termed "*riveted lattice*" and "*Phœnixville truss,*" in respect to these qualities, and it should be clearly understood that the essential difference between the two forms lies in the mode of forming the connections. The compressive members of both forms are composed of sections of iron, united by riveting. The floor beams and track stringers, if of iron, would, for a double track bridge, where two trusses are used, and the headway below the track is limited in depth, be composed of beams formed of plates and angle irons united by riveting, as in the case of the new bridge at Albany. But when we come to examine the mode of connecting together the different parts of the two several bridges, we shall observe a marked difference of system, which influences the above-named principal qualities of the two styles of bridges.

Strength.—In comparing the two styles for strength, we must assume that the factor for safety is the same in both cases. This requires for the riveted lattice larger areas of iron in the tensile members; first to replace the area lost by riveting; this will show an excess of material over pin and eye bars of about 15 per cent; secondly, to make up for lost strength of plate, channel and angle iron used in "riveted lattices," as compared with the double-refined bar iron used in the tensile members of the "American" truss, this will be as 50,000 to 60,000, or 20 per cent. In the compressive members, the difference of strength is greatly in favor of the Phœnix column, which is the strongest form of strut that has yet been devised. In the experiments made on the Boyne Viaduct in Ireland, a riveted lattice column 3 feet wide and 28½ feet long, a ratio of about 9½ diameters, failure took place in the direction of its greatest width, with 19,500 pounds per square inch. In experiments made on Phœnixville columns, at Phœnixville, in 1870, a column 18 feet long, and 12 inches diameter over flanges, a ratio of about 18 diameters, bore 36,600 pounds per square inch before yielding; an excess of at least 75 per cent. of strength, when the ratio of length to diameter is considered. The practical effect of these differences of strength upon the designs of the two kinds of bridges is, that in the Phœnixville bridges the material is better concentrated along the lines of strain, the panels are wider and the connections less frequent, the trusses can be made higher without materially increasing the weight of the web or bracing system, hence throwing less leverage and strain upon the upper and lower chords, and allowing of less sectional area and weight on them. Therefore, in two bridges, one of each style and system, and the same length of span, rolling load and factor of safety, the Phœnixville and Fink bridges accomplish their work with less weight of iron. In long spans the saving of dead or useless weight, in these American designs of iron bridges, is very great and we arrive at the indisputable result that, first, with the same weight of iron, the American or Phœnixville system gives at least 50 per cent. stronger bridge; or, second, with the same strength, the American system takes a less weight of iron and costs less money. There is another kind of strength which bridges are required to possess, viz.: that of sustaining themselves against sudden shocks, or blows, caused by trains running off the track while crossing them, or by vessels striking them when over navigable waters. The advocates of riveted bridges have always maintained their superiority in this respect; one part, they say, may be bent, or even broken, without causing the bridge to fall. But experience has shown that a well-designed American bridge, like the Phœnixville truss, will stand as severe a shock as any other kind. A train of freight cars crossing the new iron bridge at Albany, at the rate of about 20 miles an hour, was thrown from the track by a brake block falling down. The force of the blow against the trusses of the bridge tore off the sides of two of the cars, bent 2¾ inch round rods, and pushed one of the posts clean out and into the river, yet the bridge still continued to carry trains, with very little visible deflection; a temporary post of wood was inserted, and as soon as possible a new Phœnix column of iron was put in the place of the old one, all without delaying trains or trestling up the bridge. Could riveted lattice have done any better?

Durability.—The durability of a bridge is measured, first, from its resistance to deterioration by use; in other words,

wearing out. Second, by its resistance to deterioration from rust. Experience has shown that bridges give out first at the joints of connection. This is owing to the practical difficulties of so designing the connections, or points of bearing, that the pressure per square inch upon the bearing surfaces shall not exceed a certain maximum, which experience teaches should not be over 10,000 pounds per square inch, unless the joint is perfect. It may easily happen that one part is strained much less, and another with much more, than the intended strain.

In the American, Phœnixville, Fink, Post, Pratt, Whipple and Bollman trusses, there is perfect uniformity of pressure upon the bearings. In the first place, the accuracy of workmanship resulting from the parts all being finished by machinery, and by the use of metallic templates, is such that no error can be made in the length of struts or eye-bars of over 1-64th of an inch, or between the diameter of pin and hole of over 1-100th of an inch. The upper chord and column struts are faced off square in a lathe and abut. The cast-iron joint-boxes are also turned off in a lathe, so as to insure a perfect fit. The chord-bars and tie-rods are drilled on a wrought-iron bed-plate, so that the lengths to hole centres are mathematically correct.

The distance between the end-pins of a 250-foot clear span, consisting of 20 joints, does not vary 1-16th of an inch from the calculated height. At a given temperature the fit of a hole and pin is so perfect that one pin can be slipped into the holes, at each end of a dozen eye bars lying on each other.

Secondly.—In the Phœnixville bridges the circular section of the chord and column struts, with the pins which transfer the strains, passing through the centre of their diameter, ensures that the centre of pressure shall always coincide with the centre of gravity of the section.

This is a point seldom or never attained in riveted connected bridges. (See the discussion on Prof. Callcott Reilly's paper, No. 1,110, read before the Institution of Civil Engineers of England, April 25, 1865.)

The connection of the cross floor beams by stirrup bolts, passing over the pins which are held up by the tie-rods, gives a more direct bearing than in riveted lattice bridges, where their beams are riveted to the lower flanges of the truss or girder, in which case there is an excess of strain upon the supporting rivets which are nearest to the load.

In riveted-connected bridges such accuracy of workmanship and consequent uniformity of strain as is found in the machine-made American bridges is never attained. The holes are made to coincide by drifting and reaming, the rivets consequently do not fill them perfectly, and while some are scarcely strained at all, others are overstrained.

When the wedges are struck there is a deflection, which is increased by the first passing load, and the bridge never returns to its original camber, showing that there has been a squeezing of the compression parts together, and a stretching of the tensile members.

The American truss bridges, on the other hand, are built to a certain calculated camber, and when the load, be it ever so great, is removed, they return to the given camber again.

From the mode in which the struts and ties are riveted to the flanges of riveted lattice girders, there is a heavy cross strain thrown upon the joint, as the angle of direction of the strain, instead of turning round a point, viz.: centre of pin, has to turn two angles. Taking all these things together, it is evident that under a heavy traffic the riveted connections will fail before the more accurately constructed pin connections will.

Deterioration from Rust.—Riveted-connected bridges are attacked by rust, and deteriorate more quickly than the pin-connected bridges. Owing to the concentration of strains, and consequently of material, the American bridges expose nearly 50 per cent. less surface to the weather than do riveted lattice girders. All their parts are accessible for painting, except the interior of columns and chords, which are thoroughly painted, say japanned, while hot, before erection, and are sealed against moisture by the tightly-fitting tenons of the joint-blocks and post-feet.

Nine years' experience has shown that the paint on the inside of one of these columns, standing in a very exposed situation, is as fresh as the day it was put on. This is reasonably to be expected; for the decay of painted surfaces is caused by the alternate hot sunshine, drying out the oil, and rains then washing off the dry paint. But oil paint, when protected from the sun and rain and frequent hygrometric changes, is nearly indestructible. If, however, from peculiar circumstances of climate, engineers should prefer to have a means of inspecting and if necessary repainting the interior of Phœnix columns, it is only necessary to make a series of oblong openings, which will detract but little, if any, from the strength of the column.

Riveted lattice bridges decay at the points of contact of bars with each other and with the plates. It is impossible to make the joints so tight that moisture will not find its way between the surfaces, and it cannot be got at to paint. The vibration of the bridge breaks the film of paint at the joint, and the moisture finds its way in. All these points have been discovered by actual use.

Ease and Cost of Transportation.—All the parts are fitted at the works, and put together there before shipment, so that there is no riveting or machinists' labor required on the scaffolding.

Common laborers, under intelligent foremen, can erect these American bridges. Skilled mechanics are not required. Railway contractors who have seen the opening of their lines delayed by strikes occurring among mechanics, who have been sent at great cost to foreign countries, will appreciate this merit most thoroughly.

The Ohio & Mississippi Railway Company, being in dread of a freshet, which might have washed away their scaffolding, erected a through span of 165 feet long, of one of the Phœnix Girders, in 8½ hours, picking up all the iron from the embankment, placing it on small cars and running it out to the staging, and then erecting it in place, so that the bridge was self-supporting. Had this been a riveted lattice bridge it could not have been made self-supporting, with the same force of men, in less than ten days; meanwhile the freshet would have carried it away.

Cost.—The cost, per pound, of the Phœnixville bridges exceeds that of riveted lattice bridges, as they are made of a better quality of iron, corresponding to the English Lowmoor brands in their tensile members; the workmanship also is better.

When the cost of erection is taken into account in both cases, it may happen that the total cost per pound of one kind will not exceed that of the other. One thing, however, is certain—the cost per span of the Phœnixville and other American bridges, for spans of over 100 feet, will be less than that of riveted lattice bridges; and as the length of the spans increases, the difference in favor of the American bridges will largely increase. This is when the actual strength is the same in both cases. On the other hand, if the cost of the two bridges coincides, there will be a great excess of strength in favor of the American bridge.

The general merits of the American pin-connected bridges cannot be better shown than by the following facts: The Pennsylvania Railway, the Baltimore & Ohio Railway and Illinois Central Railway have always used pin-connected bridges. The International Railway Bridge Company of Canada, an English corporation, with English engineers and capital, and a great pressure brought to bear upon them by English bridge-builders, adopted the American pin-connected system for their bridges over the Niagara River.

When Captain Tyler, of the Royal Engineers, was here a year since, he witnessed the testing of some of the spans of this bridge and openly admitted its superiority on every point after the tests were made, being perfectly incredulous before they were made. The Inter-Colonial Railway Company, now constructing a railway from Quebec to Halifax, submitted the bridging of their water-ways to public competition, merely specifying that the bridges were to have a certain factor for safety, also specified the spans, widths, material and elevation above the water, and left the designs and detail of construction to the competing parties. Again the American pin-connected bridges won the day, the Phœnixville Bridge Company getting the contract from this English company for all the long-span bridges, after competing with eighteen English and one Belgian bridge firm. I am told by an engineer connected with the works, that the aggregate price of the Phœnix Bridge Company was $70,000 less than any other received.

In reviewing this matter of iron bridges, and comparing the pin-connected and riveted lattice girders, I have not mentioned the tubular girder bridge, as it is no longer in use, being behind the mechanical and engineering spirit of the age.

Some of the long spans of the Victoria Bridge at Montreal (tubular girder), have sunk at the centres over six inches, and there is much anxiety felt for the security of the bridge. This is a serious matter when we consider the cost, over seven millions of dollars, and that it has been finished only about twelve years.

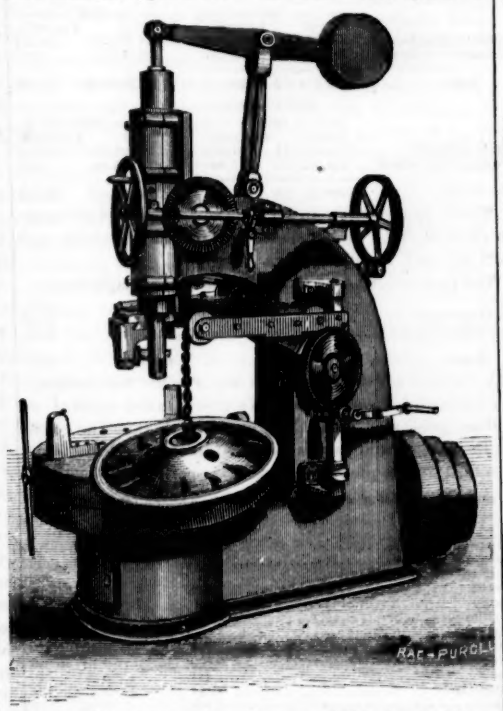
I remain yours, most sincerely, W. W. EVANS,
Member Institution of Civil Engineers, Member American Society of Civil Engineers.

Car-Wheel Boring Machine.

The machine represented by the engraving is manufactured by the New York Steam Engine Company, whose office is at No. 98 Chambers street, New York.

It is thus described by the manufacturers:

It is a vertical machine, the frame being very heavy. It is provided with a chuck for receiving wheels of 36 inches diameter and under; the jaws are made of steel and of proper shape; the chuck has a universal motion. The gearing is very powerful. The main cone has three changes, 24, 21 and 18 inches diameter, 4½-inch belt. The main boring spindle is



6⅛ inches diameter, and has a traverse of 28 inches, and has a steel arbor 3⅛ inches diameter, fitted to it for receiving the cutter, and when ordered it is also fitted with taper universal cutters of any desired diameter. Distance from top of chuck to lower side of spindle bearing is 27 inches. It is provided with a wrought-iron crane, which is attached to the frame and swings entirely to the center of the chuck, dropping the wheel and lifting it out without touching the jaws of the chuck; we also fit to the frame a facing rest, with self-operating feed, that will face off the hub at the same time the hole is being bored. This rest is so arranged that when not in use it will swing entirely out of the way, which requires but a minute to do. The main spindle is counter-balanced by lever and weight; we send with it an improved hollow self-oiling counter-shaft, with hangers and pulleys and steel wrenches. The working parts are fitted by scraping. It will bore 80 wheels in 10 hours.

Overworking Railroad Employes in England.

A recent number of *Iron* says:

"The railway employes appear, like the agricultural population from which they have mainly been drafted, to have had raised up among them a Moses, in the person of Mr. C. B. Vincent, originally a railway clerk at Worcester, a post he of course did not retain long after setting on foot a short-time agitation and organizing a combination among his *confreres*. At a recent public meeting on the questions of the hours of railway servants and their claims for compensation for injuries received in the performance of their duties, Mr. Vincent attended, and stated a number of facts, vitally important, no doubt, to railway servants, but no less important to railway travellers, and even railway shareholders, as upon them depends at least a moiety of the fearful and unnecessary casualties which have, and more of late than ever, brought mourning and misery into many a household. The first thing, Mr. Vincent stated, that put the idea of the movement he had originated into his head, was the sight of a poor fireman a leep on the front plate of his engine, after seventeen hours' labor, and who was thus snatching a few minutes' rest before again starting on a seven hours' journey. And this system of excessive strain presses upon all railway servants, from porter to station-master. The first example adduced by Mr. Vincent was that of the dreadful accident in August last between Wilton and Salisbury. This occurred through a mistake of the station-master at the former place, who had to perform the duties of an entire staff with only one porter to assist him, and was so harassed with overwork and want of sleep at the time as to be perfectly incapable. The station-master of Kirtlebridge, where another deplorable accident, it will be remembered, occurred last year, was proved to be similarly overworked and underhanded. An engineman is referred to as having been seen entering on the twenty-fifth hour of his duty; and an engine driver on a main line from London describes himself as so overcome with sleep from protracted labor and vigil that he could scarcely keep his eyelids open. To keep himself awake he said he had chewed some tobacco, and put it into his eyes. Had the passengers by that train known of the driver's condition, they would, we opine, have managed to keep their eyes open without the aid of tobacco, however sleepy they might have been. As to the guards, Mr. Vincent observed that he hoped, before taking an excursion ticket in the Summer time, his hearers would pause and inquire how long the guards had been at work. He could, he said, produce men who, in the excursion season, had never had their clothes off from Sunday to Sunday. Another statement of Mr. Vincent's, if true, would show that the companies do not favor their colliery customers over outsiders for nothing. 'Engine-drivers were rewarded at the end of the year if they saved coal. In some districts of the country they could save more than in others. They could save most coal in the coal districts. He had not found many of the men discharged for taking coal from the wagons of private individuals, but if they were found stealing from the company's stores they were summarily dealt with.' The question of compensation to railway servants, when injured in the execution of their duty, becomes important when considered in connection with the neglect of rules laid down for their safety, a neglect enforced, there cannot be a doubt, by many companies on pain of dismissal. And the fact of the law refusing to give compensation in such cases, has, if the speaker can be believed, had a result which, for the credit of human nature, we would rather not believe. Mr. Vincent is reported to have complained bitterly that when accidents took place the passengers were carefully attended to while the poor servants were left to suffer, adding that he had known more than one case in which men had bled to death whose lives would have been spared had they received proper attention. There are other charges advanced, with all the adjuncts of place and circumstance, which certainly call for investigation, and, if found true, deserve the best attention of juries in compensation cases, as well as of the great inquest of the nation, whose energies, it is promised, are in the meantime to be withdrawn from questions of theoretical politics to those not less pressing ones which concern the health, happiness and lives of the lieges."

Transportation in Congress.

In the Senate, on the 6th:

Mr. Sargent, of California, introduced a bill granting to the Nevada Narrow-Gauge Railroad Company right of way through the public lands for a railroad. Referred to the Committee on Railroads.

The bill to provide for the payment of the bonds of the Louisville & Portland Canal Company was taken up, the pending question being to refer it to the Committee on the Judiciary. After discussion it was referred to the Committee on Finance, which was the action favored by the advocates of the bill.

In the House, on the 6th:

On motion of Mr. Sawyer, of Wisconsin, permission was given to the Committee on Public Lands to report back the Senate bill extending to December 31, 1876, the time for completing the Central Railroad of Wisconsin. The bill was thereupon reported and discussed. After considerable debate the bill was passed.

In the Senate, on the 7th:

The Chair laid before the Senate a communication from the Secretary of War transmitting a report of the Board of Engineers appointed to examine and report upon the James River & Kanawha Canal project. Referred to the Committee on Transportation Routes.

Mr. Oglesby, of Illinois, presented concurrent resolutions of the General Assembly of the State of Illinois, in relation to the rates of freight and passage on the Union Pacific Railroad and its branches. Referred to the Committee on the Judiciary.

THE SCRAP HEAP.

The Joliet Iron & Steel Works.

At a meeting of stockholders of the Joliet Iron & Steel Works, April 3, the committee appointed at a previous meeting reported a proposition to be submitted to the stockholders, which is, in general terms, that the creditors be given stock in settlement of claims, and continue the works. Both creditors and stockholders are anxious to have the works resume operation, as there is now a demand for all the iron and steel that can be turned out. The report was adopted, and the meeting adjourned.

Railroad Manufactures.

The Topeka (Kansas) Rolling Mills have contracted to reroll 25,000 tons of rails for the Union Pacific, Kansas Pacific and Atchison, Topeka & Santa Fe roads, which will keep the works busy some months.

The St. Louis Bolt & Iron Company's mill is running extra time on large orders from the Union Pacific and Louisville & Nashville roads.

The Milwaukee Iron Company are about to put up a new mill for the manufacture of all kinds of merchant bar iron. The buildings will be 216 by 80 feet, will contain three trains of rolls, one 9 in., one 12 in. and one 16 in., and five Siemen's regenerative furnaces. Its capacity will be 50 tons of bar iron daily.

The Cummings Car Works at West Bergen, N. J., have recently shipped a lot of milk cars for the New Jersey Midland, and an outfit of special cars for a traveling circus.

British Rail Exports.

For the months of January and February the exports of railroad iron from Great Britain amounted to 96,311 tons in 1874 against 91,551 in 1873. Of these amounts, the United States took 48,901 tons, or more than half, in 1873, and 16,978 tons, or little more than one-sixth, in 1874. The United States remains, however, the largest single customer for British railroad iron, the next being Australia, which took 11,897 tons in 1874; then Egypt, with 8,894 tons; Russia, with 6,524; British India, with 6,153.

PERSONAL.

—J. H. Stewart, General Superintendent; A. J. Mead, General Freight Agent; J. H. Jenkins, Assistant Superintendent, and H. W. Mead, Agent at Winona, of the Winona & St. Peter Railroad, have resigned their respective positions.

—John Dykeman, Master Mechanic at Green Island, N. Y., and Benjamin Lacca, Roadmaster of the Rensselaer & Saratoga Railroad, have resigned their positions.

—Mr. Henry R. Remsen, for many years and up to the time it was merged into the United New Jersey Company, a director of the New Jersey Railroad & Transportation Company, died in New York, April 6.

—Mr. John Headden, for many years Master Mechanic of the New Jersey Railroad, and later of the New York Division of the Pennsylvania Railroad, resigned his position April 1.

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Editorial Announcements.

Addresses.—*Business letters should be addressed and drafts made payable to* THE RAILROAD GAZETTE. *Communications for the attention of the Editors should be addressed* EDITOR RAILROAD GAZETTE.

Contributions.—*Subscribers and others will materially assist us in making our news accurate and complete if they will send us early information of events which take place under their observation, such as changes in railroad officers, organizations and changes of companies, the letting, progress and completion of contracts for new works or important improvements of old ones, experiments in the construction of roads and machinery and in their management, particulars as to the business of railroads, and suggestions as to its improvement. Discussions of subjects pertaining to* ALL DEPARTMENTS *of railroad business by men practically acquainted with them are especially desired. Officers will oblige us by forwarding early copies of notices of meetings, elections, appointments, and especially annual reports, some notice of all of which will be published.*

Advertisements.—*We wish it distinctly understood that we will entertain no proposition to publish anything in this journal for pay,* EXCEPT IN THE ADVERTISING COLUMNS. *We give in our editorial columns* OUR OWN *opinions, and those only, and in our news columns present only such matter as we consider interesting and important to our readers. Those who wish to recommend their inventions, machinery, supplies, financial schemes, etc., to our readers can do so fully in our advertising columns, but it is useless to ask us to recommend them editorially, either for money or in consideration of advertising patronage.*

THE RAILROADS OF EUROPE.

The French Government publishes at intervals of a few years a collection of statistics relating to the railroad systems of all the countries of Europe, prepared for the Department of Public Works of the nation by the Statistical Bureau of the General Directory of Bridges and Highways and Railroads, and entitled "The Railroads of Europe—General Results of their Operation," (Chemins de Fer de l'Europe—Resultats generaux de l'exploitation).

The last of these publications, issued but a few weeks ago, contains the figures for the years 1866 and 1867, the administration having found it impossible to make a complete collection earlier, many of the separate countries being very much behind with their own reports.

The work is really a very simple one, consisting of a series of tables with sixteen columns, each giving a statement in figures of some result of the working of *every railroad* in *every country* of Europe, embracing altogether no less than 535 lines and systems of lines. The different items of information are: Total length worked at the close of the year; average length worked during the year; gross traffic receipts; working expenses; net earnings; the three last items per kilometre; proportion of working expenses to receipts; and all the preceding items for both 1866 and 1867; difference in the net earnings for the two years, there being columns for increase and decrease, in gross, per kilometre, and in the percentage; and a wide column for observations.

Most interesting to the general readers are the summaries given in connection with these tables and deduced from them.

We learn from this work that in 1867 in three little countries—Baden, Oldenburg, Brunswick and Reuss—*all* the railroads were worked by their Governments; in fourteen—Prussia, Bavaria, Wurtemburg, Kingdom of Saxony, Mecklenburg, Hesse Darmstadt, the Duchy of Saxony, the Free Cities, Austria, Belgium, Russia, Sweden and Norway and Switzerland, the State worked a part of the railroad system; and in ten—Anhalt, Austro-Hungary, Denmark, Spain, France, Great Britain and Ireland, Italy and the States of the Church, the Netherlands and Grand Duchy of Luxemburg, Portugal and Turkey in Europe—the whole railroad system was worked by corporations.

At the close of the two years the lengths in miles worked by the State and by companies respectively were:

	1866.	1867.
Roads worked by the State	7,554	8,111
Roads worked by companies	42,755	44,827
Total	50,313	52,938

The increase thus was 2,625 miles, or 5.22 per cent., having been 7.32 per cent. in State railroads and 4.85 per cent. in company railroads.

The number of new lines or sections of lines opened in 1867 was 163, with a total length of 2,641 miles—the difference between this figure and that given before being caused by the taking up of 16 miles of road. Of this new road, 730 miles was in France, 559 miles in Germany, 502 miles in Great Britain and Ireland, 291 miles in Russia, 193 in Austria-Hungary, 124 miles in Italy and the States of the Church, 86 miles in Belgium, 77 miles in the Netherlands and Grand Duchy of Luxemburg, 56 miles in Sweden and Norway, and 25 miles in Spain.

The *average* length worked by States was 7,540 miles in 1866 and 8,029 in 1867; the average worked by companies, 40,523 miles in 1866 and 43,296 in 1867, the total average mileage worked being thus 48,063 miles during the first and 51,325 miles during the second year.

The working of this mileage gave the following results:

GROSS EARNINGS.

	1866 Total.	1866 Per mile.	1867 Total.	1867 Per mile.
State railroads	$71,656,641	$9,504	$81,525,261	$10,154
Company railroads	430,596,834	10,626	463,313,587	10,701
Total	$502,253,475	$10,449	$544,838,848	$10,615

WORKING EXPENSES.

	1866 Total.	1866 Per mile.	1867 Total.	1867 Per mile.
State railroads	$37,330,827	$4,951	$44,432,785	$5,534
Company railroads	204,043,887	5,035	223,906,741	5,172
Total	$241,374,714	$5,022	$268,339,526	$5,228

NET EARNINGS.

	1866 Total.	1866 Per mile.	1867 Total.	1867 Per mile.
State railroads	$34,325,814	$4,553	$37,092,476	$4,620
Company railroads	226,552,947	5,591	2 9 406,846	5,529
Total	$260 878 761	$5,427	$276,499,322	$5,387

These figures show an increase in 1867 of 8.48 per cent. in gross receipts, 11.17 per cent. in working expenses, and 5.99 per cent. in net earnings.

The proportions of working expenses to receipts were:

	1866.	1867.
State railroads	52.10	54.50
Company railroads	47.39	48.33
Total	48.06	49.25

A very interesting table gives the average net earnings per kilometre in each State. We give it below reduced to dollars (gold) and miles. To compare with American roads for the present and past two years at least an eighth should be added for the premium on gold:

AVERAGE EARNINGS PER MILE OF THE RAILROADS OF EUROPE.

	1866.	1867.	Inc. or Dec.
France	$7,357	$7,162	—$195
Austria-Hungary	7,247	7 760	+ 513
Great Britain and Ireland	6,721	6,599	— 122
Prussia	5,676	5,580	— 96
Saxony	4,761	6,472	+1,711
Wurtemburg	4,478	4,268	— 210
Belgium	4,069	3,824	— 245
Grand Duchies, etc.	3,989	4,199	+ 210
Bavaria	3,820	4,196	+ 376
Russia	3,444	4 084	+ 640
Switzerland	3,147	3 271	+ 124
Spain	2,388	2,467	+ 79
Italy and Papal States	2,330	1,882	— 448
Netherlands and Grand Duchy of Luxemburg	2,312	2,078	— 234
Portugal	1,256	79	— 466
Denmark	1,231	1,256	+ 25
Sweden and Norway	947	917	— 30
Turkey in Europe	741	185	— 556

For the sake of comparison we add here the figures per mile for the United States in Poor's Manual, embracing 57,323 miles of road, and for the fiscal year which expired next before 1872, by the side of the figures for all Europe in 1867, adding one-eighth to the latter to equalize gold and currency:

	Europe.	U. S.
Gross earnings	$11,942	$8,256
Working expenses	5,882	5,366
Net earnings	6,060	2,890
Proportion of expenses to earnings	49.25	65.00

This comparison will bear study. It is probably a little favorable to the American roads from the fact that the tables from which the latter figures are obtained did not cover some three or four thousand miles in operation which is made up almost entirely of new roads, whose traffic would probably average little more than one-third of the average. Still, as there is nothing like so great a proportion of new roads among the European lines, the omission of these lines is not altogether without advantage for fairness in comparison. Let us compare the differences, which are in all cases the excess of the European over the American roads. These are:

In gross earnings	$3,686
In working expenses	516
In net earnings	3,170

In a word, the European railroads earn $3,686 more per mile with expenditure greater by only $516, which enables them, with gross earnings 44½ per cent. greater, to earn for their proprietors nearly 110 per cent. more per mile of road. This is caused, of course, by the lower cost in Europe of the items which enter into working expenses, notably labor and materials, both of which are higher here than in almost any other civilized country of the world.

Let us take some of the different American States in which the statistics are collected and compare them with the European roads as a whole:

	Gross Receipts.	Proportion of Earn'gs to Exp.	Net Earnings.
Europe, 1867	$11,942	49.25	$6 060
Massachusetts, 1872-73	15,950	73.29	4,261
New York, 1871-72	15,717	69.03	4,868
Pennsylvania, 1872	17,680	64.00	6,361
Illinois, 1871-72	8,108	65.61	2,789
Minnesota, 1872-73	3,434	79 80	690
United States, about 1871-72	8,256	65.09	2,890

The statistics given in the French report do not include anything concerning the bulk of traffic or the average rates received per ton or passenger per mile, so that in these important particulars we can make no comparison, nor say just how much it costs to do these units of work there. What does appear clearly is: That in Europe half the charge collected by the carrier goes for expenses and half to the carrier for income on his investment; in America two-thirds goes for expenses and one-third for income on the investment.

In Europe the proprietors received, in 1867, $6,060 per mile of road as profits; in America, for the last year reported, the proprietors' income was $2,890 per mile, or considerably less than half as much.

Evidently the only thing which has made American railroads so profitable as they are is their low capital cost. We cannot compare this with that of the railroads of all European countries, but it is nearly four times as great in England, three times as great in France, and nearly twice as great in Germany as here, and the average income per dollar invested is probably quite as great here as in Europe. This is very far from saying that the income is as satisfactory here as there. The average interest on money is at least one-half greater here than in Europe; and while there 5 per cent. would be accepted as a fair interest on a safe investment, certainly 7½ per cent. would be as little as would be thought sufficient in this country, taking it as a whole.

THE PROPOSED MECHANICAL LABORATORY.

Last week we published a circular issued by the committee of the Master Mechanics' Association to whom this subject was referred. While it is apparent that such a laboratory could be very useful to the members of the Association, and to railroad companies generally, on the other hand it is equally apparent that its organization and management will be attended with some difficulties and will require more than ordinary skill and care to make it successful and to avoid very serious errors into which such a project would be liable to fall. The committee has therefore adopted a wise plan, we think, in issuing this circular, and has presented some very pertinent questions for the consideration of the members of the society.

The chief difficulties that will be encountered in organizing such a project will be in having it intelligently and honestly managed. To undertake to conduct mechanical or scientific investigations without intelligent supervision would of course be absurd. The question quite naturally arises, How shall the knowledge and skill to supervise such work be provided? This difficulty presents itself in the very first practical step which has thus far been proposed. As most of the members of the Association knew, at the last meeting an appropriation of $500 was made for the purpose of procuring a dynamometer for testing the resistance of cars and trains. Now any one who has ever had any experience in the use of dynamometers knows that an instrument which acts simply by the tension of one or more springs, if placed between an engine and a train, will be a very uncertain indicator of the power required to draw the train. To get at any trustworthy facts regarding this very imperfectly understood subject will require a very carefully constructed instrument, and one which will make an accurate record of a number of other phenomena besides the tension on the instrument itself. Now we have no means of knowing whether the committee has expended the appropriation which was made for that purpose, but we can very readily see that it might be a very perplexing thing for such a committee to decide what kind of instrument should be procured or constructed for the purpose. Probably no more inefficient method could be adopted, for designing machines, than to appoint a committee for the purpose. We of course do not mean to say that the men on that committee would not design and construct a very good instrument of that kind. Each one of them, doubtless, if called upon would do such work well and themselves and the Association credit, but then it would be the work of the individuals and not of the committee as a whole. No man can exercise his ingenuity or his skill to best advantage unless he is free to act, and not restrained by the ideas of others. Now it will be exactly so if experiments are made. It will be impossible for any committee to specify exactly how they shall be made, and therefore it will be necessary in the management of such a laboratory to place the executive power in the hands of some one person, subject of course to some sort of a board of control, or committee or trustees, or whatever it may be called. If the work which is done with such a laboratory is to have any value, it will be the result of careful and intelligent study and investigation. Mere desultory effort, either on the

part of a committee or of any of its members, would not be likely to yield any valuable results. It is necessary to dig deep if you want to discover new truth in science; and just as gold is often found encased in quartz, which must be crushed and washed with the utmost care to separate the pure metal from the stones and dirt, so scientific truth, even when discovered, is often imbedded in the hardest and most forbidding kinds of surroundings, and only the most industrious and careful exertions will extract the one from the other. Now such labor, whether in pursuit of gold or truth, is not holiday work. If the questions which need solution could be solved easily, then a mechanical laboratory would not be necessary. If we take the question which has already been presented for solution, that of the resistance of trains, it will be found that to prepare the necessary apparatus will require much more time than most persons are apt to suppose. The apparatus for making such experiments will require to be designed and constructed with great care and skill, and to be trustworthy the experiments should be repeated often. This is only one subject. If we take the comparative values of fuel, it is even more difficult of solution than the resistance of trains, and only an elaborate series of experiments will determine it practically. Such experiments it would require weeks to make, and to have any value would need to be recorded and tabulated with the greatest care and accuracy. It is needless to say that no master mechanic or other person engaged in any regular occupation could give the requisite time to making such investigations. We have named only two subjects. There are of course others which need quite as much to be elucidated by experiment. The strength of boiler seams, braces and stays, the form and proportions of smoke-stacks, the relative value of lubricants, the efficiency of different kinds of valve-gear, the strength of materials, and the relative purity and incrustating properties of different kinds of water, would be standing subjects for investigation. No experiments, perhaps, would render so much service to railroad companies as an annual series of competitive trials with locomotives. These are only such subjects as now occur to us for experiment. There are, of course, many others which would arise and which cannot now be anticipated. Now we believe it would be quite impossible, without compensation, to secure the kind of ability and the amount of work which would be required to conduct such experiments, and to manage the mechanical laboratory, and therefore in organizing such an experimental department in connection with the Association, provision should be made for securing the services of some competent person in the capacity of say an experimental mechanic or mechanical investigator. Such a person should have both practical experience and scientific knowledge, and should be of known and tried integrity, as nothing would be more disastrous to such a project than to have it corrupted at the fountain head by bribery in any form whatsoever.

In a previous number of the RAILROAD GAZETTE we have published the proposition of Professor Thurston to the trustees of the Stevens Institute at Hoboken. Such a connection with an established institution of learning, with perhaps the best equipped laboratories in the country for both physical and chemical investigation and experiment, would certainly be a very advantageous one. It would, to some extent at least, secure the co-operation of the teachers in that institution, among whom are men very eminent in chemical, physical and mechanical research.

We have thus far not referred to the pecuniary aspects of the project. There will, we believe, be very little difficulty in providing all the money necessary to carry it out if some practical scheme is once adopted, which will make it reasonably certain that the money will be used wisely and for the purposes intended. It sometimes happens that a project of this kind fails for the want of some definite and clearly-defined method of organization. To provide for this contingency we will suggest a plan which, although possibly not the best, may nevertheless form a nucleus for discussion and the adoption of a better. The plan is this: Let a committee consisting of the President, Vice-President and three members elected by the Association each year have control of the laboratory; the present committee to appoint a board of trustees consisting of the president of the Association, one superintendent and three Presidents of railroads, in whom the title of all property acquired shall be vested; vacancies to be filled by the board itself; the committee controlling the management of the laboratory also to be a committee of "ways and means" to present at each meeting a plan for procuring contributions, and a report showing all receipts and expenditures of money for the laboratory; the plan and reports to be subject to the action of the Association after presentation; the mechanical investigator or investigating engineer, who is to have charge of the laboratory, to be elected by the Association each year.

This is of course only the roughest kind of a suggestion, and will require considerable elaboration before it will be in working order. The object in vesting the title to the property in the hands of a board, a majority of whom are presidents of railroads, is simply to give railroad companies confidence that it will not be diverted from the original purposes for which it was intended.

The questions propounded in the circular issued by the committee having this subject under consideration, while they will elicit the opinions of the members, and serve to call their attention to the subject, are some of them nevertheless hardly capable of exact answer at the present time. To the first question, "Should such a laboratory comprise apparatus for the solution of mechanical questions only, or for chemical also?" it is difficult to answer. It of course would be folly to equip a chemical laboratory unless there was a chemist competent to use the apparatus. If the proposition of the Stevens Institute should be accepted, it would probably not be necessary to have chemical apparatus, as that institution has already a very good laboratory of that kind. At any rate it is somewhat questionable whether in the beginning it is desirable to have chemical apparatus, as there are laboratories in all parts of the country in which all kinds of experiments and analyses can be made. The instruments needed are those which cannot be found in ordinary laboratories. It is, however, very difficult to give anything like a complete list of the instruments needed. Such a laboratory must of necessity grow and develop with the investigations which are made. One experiment will suggest another, just as reading one book will show the necessity of reading another. To construct such a dynamometer as is needed it will, we believe, be necessary to fit up a car specially for the purpose, which suggests the idea of equipping such a car with the requisite apparatus and making it a movable laboratory. The instruments needed which first suggest themselves are a pair of steam indicators, testing machines for testing the tensile, torsional, and compression strains of various materials, oil-testing machines and instruments, thermometers and hydrometers, a mercurial column for testing steam gauges, a powerful microscope, pyrometers for testing the heat in boilers, a vacuum gauge to show the vacuum in the smoke boxes of locomotives, a water gauge for measuring the water in a tender, a set of standard Whitworth gauges, and standard weights and measures, instruments for testing the hardness of metals, and an adjustable model of valve-gear and link-motion, an instrument for testing the accuracy of the valve-gear of locomotives. There are many special instruments, such as models of wheels and running gear, to show the tractive resistance of their different forms and proportions, which could be procured, and which would show the principles of action of these parts more clearly than is now possible. As we have stated before, such a laboratory, like a library, must grow, and could not be constructed complete at once.

Whether such a laboratory should be open to all enquirers, or only to committees, is a question which would soon solve itself. If, however, it is placed under the charge of a committee, it would seem that applications should first be made to it, and its authority be given before the apparatus can be used; otherwise there would be danger of conflict, and several parties might be disposed to do the same thing at the same time.

The proper location of the laboratory it is perhaps best not to discuss now, excepting to say that its headquarters should be where it will be likely to do the most good.

American and European Bridges.

Having secured a translation of Mr. Charles Bender's elaborate paper on this subject, part of which appears this week, together with the letter by Mr. W. W. Evans which we promised last week, we postpone any editorial remarks on the subject until its publication is completed. The subject is one of great importance the world over, and we count it as fortunate that Mr. Matheson should have given the European view of the subject at a time when these articles in favor of the American system were ready for publication.

Record of New Railroad Construction.

There was omitted from the record for last week the following:

Berks County.—Extended from Maiden Creek north 3 miles to Moselem, Pa. *Allegheny Valley.—The Eastern Extension* has been completed by laying track from Summit Tunnel to Benezette, Pa., 17 miles.

This total of 20 miles would have made the total record in last week's GAZETTE 68 miles, and the total recorded in 1874 at that time 266 miles.

This number of the RAILROAD GAZETTE has information of the laying of track on new railroads as follows:

Peachbottom.—Extended westward 3 miles to a point 13 miles west of Oxford, Pa. *Washington City, Virginia, Midland & Great Southern.*—The *Danville Extension* has been extended from Chatham southward 12 miles to a point seven miles north of Danville, Va.

This is a total of 15 miles of new railroad, making to 281 miles completed in the United States in 1874.

The following were omitted from our report of construction in 1873, published January 10:

Omaha & Northwestern.—Extended (in 1873) from West Point northwestward 15 miles to Wisner, Neb. *Midland Pacific.*—Extended (in 1873) from Lincoln west by north 26 miles to Seward, Neb. *Flint & Pere Marquette.*—The St. Clair Branch was completed from Saginaw City, Mich., eastward 4 miles to St. Clair Junction. *Savannah, Griffin & North Alabama.*—This road was extended in October of 1873 from Whitesburg, on the Chattahoochee River 11 miles northwest of Newnan, northwest 6 miles to the present terminus, 7 miles southeast to Carrollton, Ga.

This is a total of 51 miles, making 3,925 miles of new railroad completed in the United States in 1873.

Annual Meetings.

The Seventh Annual Convention of the Master Mechanics' Association will meet in Chicago, Tuesday, May 12.

The Sixth Annual Convention of the American Society of Civil Engineers will meet in New York, Wednesday, June 10.

The Eighth Annual Convention of the Master Car-Builders' Association will be held in Cincinnati, Wednesday, June 10.

EAST-BOUND FREIGHT RATES start at the lowest summer love thus early in the season, before navigation is open. At the convention of general freight agents in Indianapolis on the 2d inst., rates were adopted on the basis of a fourth-class rate of 40 cents from Chicago to New York and of 45 cents to Boston. This, however, is an improvement, as there have been in reality no rates for some time, and the railroads have accepted almost anything that was offered, in order to prevent business going to rivals. Very seldom has there been such a break in east-bound freights, which are usually maintained stiffly, while west bound rates fall far below the cost of carrying almost every year, and usually for several months of the year. With rates in both directions so low, while at the same time business is so depressed that traffic is unusually light, the roads which depend chiefly or largely on through traffic will have great difficulty in earning their working expenses, and if the combined depression of business and rates continues through the year on a large part of it, we shall see old companies as well as new ones coming to bankruptcy.

ENGINEERS THINKING OF GOING TO SOUTH AMERICA will be interested in statements in a private letter written to us recently by an American engineer who has served some years in Peru and has spent a few months recently in Chili. He says, writing from Peru: "There is no probable occupation for stragglers. Many are going away from here on account of the completion of the roads, and, funds being scarce, the works now in progress will not be rushed. I should say that Peru has all the engineers now—and more, probably—that can be utilized, and it is a miserable place to be in want of employment. Chili is now building some new roads, and many who have gone away from here have obtained employment there. How much more room there is I have no means of knowing."

A NEW FIRELESS LOCOMOTIVE, built at the Grant Locomotive Works, was recently tried at Paterson, N. J. It has four wheels, 36 inches in diameter, and 7x10 inch cylinders. The boiler is 37 inches in diameter and 9 ft. 6 in. long, and the whole engine empty weighs 6 tons. On the trial, with the water heated to a temperature equivalent to a pressure of 140 pounds per square inch, the engine ran with an ordinary loaded horse-car a distance of 7 miles. The track on which the trial was made is an ordinary horse-car track, laid on a common road with very heavy grades for short distances in some portions. The steam pressure after running the distance named was reduced to 40 pounds.

General Railroad News.

ELECTIONS AND APPOINTMENTS.

—At the annual meeting of the Lake Ontario Shore Railroad Company in Oswego, N. Y., recently, the following directors were elected: Albert F. Smith, Luther Wright, Thomas S. Mott, Theodore Irwin, Oswego, N. Y.; Geo. B. Phelps, Watertown, N. Y.; O. P. Scovel, Lewiston, N. Y.; James Brackett, Rochester, N. Y.; N. H. Curtice, Webster, N. Y.; John P. Bennett, Williamson, N. Y.; Rowland Robinson, Sodus, N. Y.; R. F. Wilson, Wilson, N. Y.; Burt Van Horn, Lockport, N. Y.; Chas. Efner, Parma, N. Y.

—At the annual meeting of the Kalamazoo & South Haven Railroad Company in Kalamazoo, Mich., March 24, the following directors were elected: James F. Joy, Detroit; Allen Potter, H. G. Wells, W. A. Wood, L. B. Kendall, Kalamazoo, Mich.; David Anderson, Bear Lake, Mich.; D. G. Wright, Uziel Conger, S. H. Rogers, B. H. Dyckman, A. D. Dyckman, George Hannah, Aug. Haven, South Haven, Mich. Allen Potter was elected President; L. B. Kendall, Treasurer; George L. Seaver, Secretary.

—At the annual meeting of the Great Southern Railway Company, March 25, the following directors were elected: T. W. Osborn, S. Conant, M. L. Stearns, J. W. Johnson, M. H. Alberger, Ephraim Tweedy, Oscar V. Dayton, C. B. Wilder, Wm. C. Alberger. The board subsequently elected officers as follows: T. W. Osborn, President; S. Conant, Vice-President; J. W. Johnson, Treasurer; Wm. F. Wheeler, Secretary, and M. H. Alberger, General Superintendent.

—Mr. John S. George, for some years Agent at Cedar Rapids, Ia., has been appointed General Agent at Milwaukee for the Chicago & Northwestern Railway, in place of S. Sanborn, who has gone to the Winona & St. Peter road.

—At the annual meeting of the Pittsburgh, Wheeling & Kentucky Railroad Company in Wheeling, W. Va., March 28, C. D. Hubbard, J. McLure, Thomas Hughes, W. K. Pendleton, Lewis Applegate and James McLuney were chosen directors. The board subsequently elected C. D. Hubbard President.

—Mr. J. B. Mulliken, late of Sterling, Ill., has been appointed General Agent of the Winona & St. Peter Railroad, with office at Winona, Minn. He succeeds A. J. Mead, late General Freight Agent, who has resigned. Mr. George W. Dye, formerly of the Western Union, has been appointed General Roadmaster of the Winona & St. Peter. It is stated that no new appointment of General Superintendent will be made in place of J. H. Stewart, resigned, but that his successor in immediate charge of the road will be a division superintendent.

—Mr. David Hoit, late Master Car-Builder of the Toledo, Wabash & Western Railway, has been appointed Master Car-Builder of the New York Central & Hudson River Railroad at West Albany, N. Y.

—The new board of directors of the Ithaca & Athens Railroad Company is as follows: Ezra Cornell, Frank C. Cornell, Chas. H. Blair, Chas. M. Titus, F. M. Finch, John Gauntlett, John Rumsey, John A. Nichols, Geo. McChain, John H. Selkreg, Rufus Bates, L. L. Tremain, A. B. Cornell.

—J. C. Neely and E. M. Apperson have been chosen directors of the Selma, Marion & Memphis Railroad Company, in place of N. B. Forrest and S. M. Meek, resigned.

—At the annual meeting of the Pacific Railroad Company of Missouri in St. Louis, March 30, Andrew Pierce, Oliver A. Hart, James Baker and David K. Ferguson were elected directors for three years. The first three are re-elected and Mr. Ferguson replaces N. C. Chapman, deceased. The board subsequently met and elected the following officers for the ensuing year: President, D. R. Garrison; Vice-President, Andrew Pierce; Secretary and Treasurer, John Dearborn.

—Mr. H. A. Wells has been appointed Southeastern Passenger Agent of the Hannibal & St. Joseph Railroad, with office at No. 1, Burnett House, Cincinnati, Ohio.

—The new board of directers of the Panama Railroad Company has elected the following officers:—President, Russell Sage; Vice President, George S. Scott; Secretary, F. W. G. Bellows; Treasurer, J. B. Houston; Executive and Finance Committee, Russell Sage, George S. Scott, T. W. Park, H. H. Baxter and Geo. J. Forrest.

—At the annual meeting of the American Steamship Company in Philadelphia, April 6, Henry D. Welsh was chosen President in place of E. C. Knight, who declined re-election. The following directors were chosen:—Josiah Bacon, John Rice, B. H. Bartol, John Price Wetherhill, D. B. Cummins, M. Baird, N. Parker Shortridge, Strickland Kneass, Edmund Smith, William D. Winsor.

—The following appointments have been made of Division Freight Agents for the different divisions of the Pittsburgh, Cincinnati & St. Louis Railway, with the territory assigned to each: Pittsburgh & Columbus Division, James Means Agent, includes the line from Pittsburgh to Columbus, with the Cadiz and Washington branches, 224 miles in all. Office at Pittsburgh, Pa.

Little Miami Division, E. F. Fuller Agent, includes the line from Columbus to Cincinnati and branches from Xenia to Springfield and Richmond, 196 miles in all. Office at Cincinnati, O.

Cincinnati & Muskingum Valley Division, R. B. Bailey Agent, includes the line from Dresden, O., to Morrow, 148 miles. Office at Zanesville, O.

Columbus, Chicago & Indiana Central, First Division, J. A. Perkins Agent, includes the line from Columbus to Indianapolis, 188 miles. Office at Indianapolis, Ind.

Indianapolis & Vincennes Railroad, Indianapolis to Vincennes, 117 miles, J. A. Perkins Agent. Office at Indianapolis, Ind.

Columbus, Chicago & Indiana Central, Second Division, J. A. Grier Agent, includes the lines from Bradford Junction to Chicago and Richmond to State Line, 399 miles. Office at Logansport, Ind.

—The Panama Railroad Company at its annual meeting in New York, April 6, elected the following directors: Russell Sage, H. H. Baxter, George S. Scott, Frank Work, John M. Burke, A. B. Stockwell, George J. Forrest, S. L. M. Barlow, B. P. Kissam, Charles J. Osborn, C. K. Garrison, T. W. Park and Rufus Hatch.

—At its annual meeting in New York, April 6, the Second Avenue (street) Railroad Company elected directors as follows: Thomas Crane, George Bell, T. W. Decker, Waldo Hutchins, Julius Wadsworth, Charles Stanford, Augustus E. Masters, Frederick De Billier, Jos. D. Fish, William S. Thom, O. Schwarzwalder, Solomon Mehrbach.

TRAFFIC AND EARNINGS.

—The earnings of the Great Western Railway, of Canada for the week ending March 13 were: 1874, £21,006; 1873, £23,640; decrease, £2,634, or 11 1-8 per cent.

—The earnings of the Union Pacific Railroad for February are reported as follows:

	1874.	1873.	Increase.	P. c.
Earnings	$607,990.28	$491,783.55	$116,206.73	23⅝
Expenses	374,956.13	289,028.42	85,927.71	29¾
Net earnings	$233,033.15	$202,755.13	$30,279.02	14¾

For the two months ending February 28 the report is as follows:

	1874.	1873.	Increase.	P. c.
Earnings	$1,228,705.49	$1,015,758.41	$212,947.08	21
Expenses	684,914.81	640,595.62	44,319.19	6⅞
Net earnings	$543,790.68	$375,162.79	$168,627.89	45

The expenses were 55.74 per cent. of earnings in 1874 and 63.07 per cent in 1873. The earnings were $1,191 per mile in 1874 and $984 in 1873.

—The receipts of the Rockford, Rock Island & St. Louis Railroad for the month of December, 1873, were $75,661.65; the working expenses, rents and taxes, $55,274.87; the net earnings, $20,386.78. For the six months ending with December the statement is as follows:

Gross receipts		$433,386.18
Working expenses	$272,268.10	
State and local taxes	22,130.15	
Interest and insurance	7,554.25	
Rent paid Ind. & St. Louis R. R.	14,109.43	
Rent paid Peoria & Rock Island R. R.	16,999 98	333,061.91
Net earnings		$100,324.27

The total expenses were thus nearly 77 per cent. and the net earnings sufficient for 1.1 per cent on the funded debt. The gross receipts were at the rate of $1,548 per mile, and the net earnings $358 per mile.

—The following companies have thus far published earnings for March:

	1874.	1873.	Inc.	Dec.	p. c.
Chicago & Northwestern	$1,039,986	$967,258	$72,728		7½
Indianapolis, Bloom. & Western	151,186	112,569	38,617		34½
Marietta & Cincinnati	161,031	180,467		$19,436	10⅔
Ohio & Mississippi	297,613	330,998		33,385	10⅛

—The receipts of grain in Baltimore for the month of March were: 1874, 1,391,911 bushels; 1873, 809,072 bushels; increase, 582,839 bushels, or 72 per cent. The increase in wheat receipts was nearly 400 per cent., and in corn about 60 per cent.

—The shipments of bituminous coal over the lines given for the three months ending March 28 were as follows: Huntingdon & Broad Top, 1874, 94,263 tons; 1873, 109,662 tons; decrease, 15,399 tons, or 14 per cent. Clearfield coal over Tyrone Division, Pennsylvania Railroad, 1874, 150,365 tons; 1873, 96,528 tons; increase, 53,838 tons, or 55¾ per cent.

—The shipments of Cumberland coal over the lines given for the three months ending March 28 were as follows: Baltimore & Ohio Railroad, 1874, 200,769 tons; 1873, 266,932 tons; decrease, 65,863 tons, or 24⅔ per cent. Bedford Division, Pennsylvania Railroad, 1874, 30,902 tons; 1873, 21,536 tons; increase, 9,365 tons, or 43⅝ per cent.

CHICAGO RAILROAD NEWS.

Chicago, Danville & Vincennes.

The officers announce that the holders of a majority of the bonds have accepted the company's proposal to fund their coupons.

Southern Dispatch Line.

This through freight line runs cars from Chicago over the Chicago, Danville & Vincennes, the Evansville, Terre Haute & Chicago and the Evansville & Crawfordsville roads to Evansville, Ind., and, by ferry, to Henderson, Ky., where they are transferred by a car-hoist to 5-feet trucks, on which they run over the St. Louis & Southeastern to Nashville, and thence over the roads further south to Mobile, Pensacola, Savannah, Charleston, etc. The line has been in operation about a year, and is said to have developed a fair business.

Chicago & Northwestern.

London papers of March 21 contain an advertisement of the Railway Share Trust Company, Limited, offering $2,500,000 of the 7 per cent. consolidated gold bonds of this company. The interest is payable half-yearly, June 1 and December 1, and the principal will be due December 1, 1902. The price is 94, or £188 for a £200 bond.

East-bound Freight Rates.

A convention of general freight agents was held in Indianapolis, April 2, at which representatives from the following roads and freight lines were present: Cleveland, Columbus, Cincinnati & Indianapolis; Pennsylvania Company; Indianapolis & St. Louis; Vandalia; Evansville & Crawfordsville; Atlantic & Great Western; Michigan Central; Marietta & Cincinnati; Cincinnati, Sandusky & Cleveland; South Shore Line; White Line; Continental Fast Freight Line; Indianapolis, Bloomington & Western; Jeffersonville, Madison & Indianapolis; Cincinnati, Hamilton & Indianapolis; Indianapolis, Cincinnati & Lafayette; Indianapolis, Peru & Chicago; Union Line.

The following schedule of rates was adopted:

Fourth-class freight from Chicago to Boston, 45c.; New York, 40c.; Philadelphia and Baltimore, 30c.; St. Louis to Boston, 55c.; New York, 50c.; Philadelphia and Baltimore, 45c.; Keokuk to Boston, 55c.; New York, 50c.; Philadelphia and Baltimore, 45c.; Indianapolis to Boston, 40c.; New York, 35c.; Philadelphia and Baltimore, 30c.; Louisville to Boston, 47c.; New York, 42c.; Philadelphia and Baltimore, 37c.; Cincinnati to Boston, 40c.; New York, 35c.; Philadelphia and Baltimore, 30c. Third-class freight, 5 cents; second-class, 10 cents, and first-class 15 cents more than fourth-class.

OLD AND NEW ROADS.

Carolina Central.

The grading is completed to within 10 miles of Charlotte, N. C. Tracklaying from Wadesboro westward will soon be commenced, and the company hopes to run trains through to Charlotte by next August.

Missouri, Kansas & Texas.

The suit brought by the town of Fort Scott, Kan., against the company to recover damages for breach of contract has been decided in favor of the town by the District Court and a judgment for $100,000 given against the company. An appeal is to be taken to the Supreme Court. The alleged breach of contract was the failure to make Fort Scott the end of a division and locate the repair shops there.

Columbia & Port Deposit.

The heaviest part of the work is done, except a section between Phite's Eddy and McCall's Ferry, where contractors are now at work. The company intends to lay track as far as Peachbottom this spring.

Chesapeake & Delaware.

The right of way has nearly all been secured for this road, and a contract for the grading is to be let shortly. The road is to run from Kent Island, Md., eastward to Harrington, Del., and will be about 45 miles long.

Hartford, Providence & Fishkill.

The trustees who are operating the road have made application to the Connecticut Superior Court for authority to build a branch for freight purposes in Hartford, Conn. The case is to be heard in Hartford, May 4.

Lewiston & Auburn.

At the annual meeting in Lewiston, Me., April 1, the directors reported that contracts had been made with the Grand Trunk Company to complete the road and to lease it when complete. An additional issue of $50,000 of bonds has been made, making the whole cost $450,000.

Greeneville & French Broad.

A meeting is to be held in Hendersonville, N. C., April 18, for the purpose of re-organizing this company.

Annapolis & Elkridge.

A bill has been pending in the Maryland Legislature to authorize the sale of the State's interest in this road to the Baltimore & Drum Point Company, which already holds a controlling interest in the private stock.

Peachbottom.

The track is laid 13 miles west of Oxford, Pa., and several miles of iron is on hand. Trains have passed over the line, but it will not be opened for regular traffic until the Susquehanna River is reached.

Baltimore, Philadelphia & New York.

This company, formerly the Juniata & State Line, is having a new line surveyed from West Chester, Pa., southwest, and announces that work will soon be begun.

St. Louis & Iron Mountain.

An agreement of consolidation has been made between this company, the Arkansas Branch, Cairo, Arkansas & Texas and Cairo & Fulton companies. It has yet to be voted on by the stockholders, but there is little doubt that it will be ratified. By the agreement, the name of the new company is to be St. Louis, Iron Mountain & Southern. It will own 685 miles of road, and the capital stock is to be $26,500,000, or $38,686 per mile. Of this stock, the St. Louis & Iron Mountain shareholders will receive $11,500,000, or 115 shares of new stock for 100 of old; the Arkansas Branch stockholders $1,548,950, being 65 per cent. of their present holdings; the Cairo & Fulton stockholders, $7,200,000, and the Cairo, Arkansas & Texas, $1,200,000, being 60 per cent. of the amount of their present stock. The balance of the new stock, $5,051,050, will remain in the treasury of the company for the present. The companies are now owned by substantially the same parties, and they can probably be more economically managed under a single organization. The consolidation would made no difference in the present management of the lines.

Springfield & Northwestern.

Work on the 11 miles of unfinished road between Springfield, Ill., and Cantral will shortly be resumed.

Colfax & Nevada.

The corparators of this company have resolved to build a narrow-gauge road and to fix the capital stock at $400,000. Subscriptions to the stock are being collected. The road will be about 25 miles long, from Nevada City, Cal., to the Central Pacific at Colfax.

Bradford County.

This road was originally intended to run from the New York State line in Bradford County, Pa., southwest through Towanda to Canton on the Northern Central. It is now proposed to extend from Canton westward through the Lycoming coal basin to Driftwood, the junction of the Philadelphia & Erie and the Eastern Extension of the Allegheny Valley. At the New York line it is to connect with a line to Binghamton.

St. Louis & St. Joseph.

The bondholders, who purchased the road at foreclosure sale, have made arrangements to organize a new company, the name of which will be the St. Joseph & St. Louis Railroad Company. The committee which has been examining the road has not yet reported, and it is uncertain whether the company will work the road or lease it.

Saginaw Valley & St. Louis.

Surveys are being made for an extension westward from the present terminus at St. Louis, Mich., as far as Tamarac Lake, in Montcalm County, about 30 miles.

St. Paul & Sioux City.

Through trains are now run from St. Paul to Omaha over this line and the Sioux City & Pacific.

Great Southern.

This line has been located from Jesup, Ga., southward to a junction with the Florida Central, six miles west of Jacksonville, Fla. From the junction north to King's Ferry, 33 miles, the right of way has been cleared and 250 men are at work on the grading.

Syracuse & Chenango.

The tracklaying on the connection between this road and the Syracuse Northern through the city of Syracuse has been completed, and the line will soon be ready for use.

Pittsburgh, Wheeling & Kentucky.

At the annual meeting recently the stockholders voted to authorize the board of directors to issue bonds and to negotiate for the completion of the road on such terms as should be deemed best for the interests of the company.

Green Bay & Minnesota.

Contracts have been made for four new locomotives and 200 freight cars, and the first locomotive has been already shipped from the Grant Locomotive Works, at Paterson, N. J.

Washington City, Virginia Midland & Great Southern.

The track on the Danville Extension is now completed to a point about seven miles north of Danville, and 12 miles beyond Chatham, Va., the late terminus.

New York & Eastern.

Connecticut papers state that work is shortly to be commenced on this projected new line from New York to New Haven. Arrangements have been made to use the New Haven & Derby road from Allingtown cut to New Haven.

Michigan Central.

According to the provisions of the mortgage, sealed proposals will be received by the trustees until noon of the 11th day of April, for the sale of the first sinking-fund bonds of said company to the value of $8,000; also, of either the first or second sinking-fund bonds of said company, to the value of $3,000.

Eastern.

This company is reducing expenses by discharging men from the shops and by reducing trains. The price of season tickets has been raised to all points between Boston and Salem.

Boston, Barre & Gardner.

A new freight house at Worcester, Mass., has been completed and opened.

Memphis & Charleston.

A special meeting of the stockholders is to be held in Memphis, Tenn., April 29, for the purpose of voting on the acceptance of the surrender and cancellation of the lease of the road by the Southern Railway Security Company, and also to consider certain proposed alterations in the by-laws of the Company.

Sinnemahoning & Clearfield.

Arrangements are being made for the construction of a railroad from Karthaus, Pa., northeast down the West Branch of the Susquehanna to the mouth of Sinnemahoning, where connection will be made with the Philadelphia & Erie. The road would be about 18 miles long.

Peoria, Atlanta & Decatur.

The Decatur (Ill.) *Magnet* of April 1, says: "This company will resume track laying the first of next week. They commence at Atlanta and lay northwest."

Arkadelphia & Hot Springs.

Arrangements have been made to organize a company to build a railroad from the Cairo & Fulton at Arkadelphia, Ark., northward to the Hot Springs, a distance of about 30 miles.

Camden, Gloucester & Mount Ephraim.

It is proposed to extend this road to Blackwoodtown, N. J., some nine miles from Gloucester. A considerable amount has been subscribed for the extension.

European Prices of American Bonds.

Quotations March 14 at Frankfort were:

Buffalo, New York & Philadelphia 6s	63⅞
Cairo & Vincennes 7s	53⅛
Central Pacific 7s, guaranteed by State of California	86
California & Oregon 6s	61
Central Pacific 6s	81
San Joaquin Valley 6s	61½
Chicago, Burlington & Quincy 4½s	68⅝
Chicago & Southwestern 7s	69¼
Atchison Branch 7s	30⅝
Grand Rapids & Ind. 7s	88
Lexington & St. Louis 6s	49¾
Missouri Pacific 6s	67
South Pacific 6s	52⅝
Mobile & Ohio 7s	77¼
Morris & Essex 7s	77
Oregon & California 7s	18½
Rockford, Rock Island & St. Louis 3½s	16⅛
St. Louis & Southeastern 7s	45½
Union Pacific, E. D., 6s	54½
Union Pacific Omaha Bridge 8s	85
South Georgia & Florida 7s	51½

Other quotations at Berlin on the 13th of March were:

Alabama & Chattanooga 8s	23½
California Extension	42
Kansas Pacific 7s	40
Port Royal 7s	25¾

At Amsterdam on the 12th were the following:

Maxwell Estate 7s	18½
Chicago & Northwestern 7s	81½
Winona & St. Peter 7s	70¾
St. Paul & Pacific 7s	15⅝
do. of 1869	18
Vincent and Brainard Ex. 7s	17⅜
At., Miss. & Ohio	27½
Mo., Kansas & Texas 7s	41⅜

Rockford, Rock Island & St. Louis.

Henry Clews & Co. brought suit against this company recently to recover town bonds to the amount of $50,000, which, with 500 shares of the company's stock, the latter had agreed to pay the firm in settlement of a suit brought in 1870, according to which an attachment on the company's property was to be vacated. The company delivered the stock (which is worth nothing), but not the bonds, for which suit was brought and

an attachment issued. A copy of the latter was served on H. H. Boody, formerly Treasurer of the company, who was alleged to have property of the company in his possession. Mr. Boody made a return to the effect that he held no property of the company, unless it should succeed in a suit against him for $227,221, which he is defending. This return being unsatisfactory to the plaintiffs, they obtained a definite return of all property of the railroad company in the possession of Mr. Boody, of which the following is a list:

"A quantity of writing paper, with the heading of said company thereon.

"One letter scale.

"One patent stamp for impressing the company's name on paper.

"One tin receptacle for holding writing paper of various sizes.

"One tin pan, for holding coins used in paying coupons.

"One upright wooden post, used in punching and canceling conpons."

A motion made to vacate the attachment was denied, however, and it will probably hold good if the company should get judgment against Boody for the $227,000.

Railroad Bills in the New York Legislature.

The House committee on Railroads has reported the following bills for consideration:

To incorporate the New York Quick Transit Company.

To incorporate the People's Railroad Company, for the purpose of providing for the rapid transit of persons and the United States mails in the City of New York.

To provide rapid transit for the City of New York.

To prohibit the issuing of passes by railroad corporations, their officers, agents or employes in this State.

To provide the City and County of New York with rapid transit for passengers and freight and the postal service.

To provide the City and County of New York with a railway system of rapid transit of passengers freight and mails.

Erie.

Mr. John Livingston, of New York, has written a letter to Mr. W. W. Shippen, of Hoboken, who was elected a director at the annual election last July and is a well known and wealthy capitalist, protesting against the issue of a loan of £480,000 Atlantic & Great Western bonds advertised in London last February as guaranteed by the Erie, and wishing to know if Mr. Shippen favored it. Mr. Shippen answers that he is not a director of the company; that he was re-elected during his absence in Europe, contrary to his expressed wish; that he sent in a positive resignation, and has not since acted or considered himself a member. Thereupon Mr. Livingston notified the Acting President of the Erie Company not to use Mr. Shippen's name as a director, as was done in the advertisements of the company's loans. Mr. Shippen, it is well to say, stated in his letter to Mr. Livingston that his object in resigning was only that he had neither leisure nor inclination to devote enough time to it to enable him to fully understand all the affairs of the company.

Chesapeake & Ohio.

This road has entered the field for business between New York and Chicago, sending by steam between New York and Norfolk, and by the Ohio River from Huntington to Cincinnati. Though the road is so circuitous, freight is carried through in ten days, and a considerable amount of the lower classes goes that way. It is taken, however, at rates which cannot possibly pay, and the chief effect of the new line is to make through business on all the lines unprofitable.

Flint & Pere Marquette.

This company completed last year a branch from Saginaw City eastward four miles to a junction called St. Clair Junction with the main line from Flint to East Saginaw at a point four miles below East Saginaw. This is the first part of what was begun on the Cass River Branch, which is graded 18 miles further east, to the Detroit & Bay City road at Vassar.

Steel rails are to be laid on the road from East Saginaw, Mich., to Holly, 51 miles, during the coming season. The old iron rails will, it is said, be used to lay on the extension from Reed City to Ludington.

Hannibal & St. Joseph.

This company is now building at its shops in Hannibal a number of parlor cars which, it claims, will be among the finest in the world. They have a grand saloon, drawing-room, stateroom, elegantly upholstered and decorated, ladies' toilet rooms, etc. One of these is to be attached to each day express train.

Plymouth, Kankakee & Pacific.

In the United States District Court at Chicago, April 1, the adjudication in bankruptcy against this company was set aside on motion of the petitioning creditors, and the bankruptcy proceedings will be discontinued if no objection is interposed.

Stock Transportation Suit.

The suit of the Pennsylvania Railroad Company against John B. Sherman and A. M. Allerton has been ended by a compromise and private settlement between the parties. The suit was brought to recover damages for alleged breach of contract by the defendants while lessees of certain stock yards owned by the plaintiff.

Lake Superior & Mississippi.

The committee of bondholders appointed at the Philadelphia meeting has not yet made a report, but it is understood that they have recommended that the company obtain a surrender of the lease to the Northern Pacific Company. Negotiations to that end are pending, and the committee will report as soon as they are concluded.

Suit has been commenced against the company in St. Paul by W. L. Banning to recover on overdue coupons.

New York & Oswego Midland.

The receivers advertise that they will sell at auction, April 25, at Middletown, N. Y., by order of the Court, two locomotives, Nos. 79 and 69, which will be delivered to the purchaser at any point on the line of the road.

Wallkill Valley.

A conference of parties interested was held in Goshen, N. Y., recently, and it is stated that, as a result, the suit for foreclosure of the second mortgage is to be abandoned. The Goshen *Standard* says that the original contractors have commenced proceedings against the company, alleging that the whole issue of second-mortgage bonds and all bonds in excess of $20,000 per mile, is in conflict with a binding contract and obligation of the company which they hold.

Searcy, Pine Bluff & Monroe.

This newly organized company purposes building a railroad from the Cairo & Fulton near Searcy, Ark., nearly due south through Pine Bluff and Monticello to Monroe, La., a distance of about 200 miles. The incorporators are M. L. Jones, J. M. Portis, A. H. Reynolds, W. N. Portis, N. T. White and James A. Tappan, all of Pine Bluff, Ark.

Montclair.

This road was sold at auction under order of the New Jersey Court of Chancery in an action for debt, April 4. The purchaser was William A. Guest, a New York iron merchant, who bought it for $6,250. Only two bids were offered. The road was sold subject to the first and second mortgages, which together amount to nearly $2,600,000. The road is 36 miles long, from the New Jersey Midland at West End to Monk's, is not in very good condition, and has little or no equipment, having been operated until a few days since by the Receivers of the New York & Oswego Midland, who last week withdrew the equipment owned by them and ceased to operate the line.

The roads is to be sold again, April 25, under foreclosure of mortgage.

Pittsburg, Fort Wayne & Chicago.

An authoritative denial is given to the report that the shops now at Fort Wayne, Ind., were to be removed to some other point. These shops are very extensive, employing about 1,000 men. During the past year they turned out 20 locomotives, 10 sleeping and 12 passenger cars and nearly 1,000 freight cars, besides doing the repairs for the Western Division of the road.

Marysville & Knight's Landing.

The California Legislature has passed a bill to provide for the construction of a road from Marysville, Cal., southwest about 25 miles, to Knight's Landing on the Sacramento River. There was formerly a railroad connection between the two places by a branch of the California Pacific, which was broken by freshets some two years since and has never been repaired.

Illinois & St. Louis Bridge.

The work on the roadway and on the eastern approaches is progressing favorably. It is expected that the bridge will be completed and ready for use during the present month and the eastern approaches by May 15. No time for the completion of the western approach can yet be fixed.

St. Paul & Pacific.

The St. Paul *Press* contradicts by authority reports that negotiations are pending for the lease of the road to the Chicago & Northwestern Company.

Wisconsin Central.

Both houses of Congress have passed the bill extending the time for the completion of this road. This will save to the company a large part of the land grant.

Northern Pacific.

A settlement has been made between the company and the bankrupt estate of Jay Cooke & Co., whereby the advances made by the latter to the former are discharged by the acceptance of the company's first-mortgage bonds and other securities. This settlement leaves the railroad company with only a nominal debt to be provided for.

A snow plow has been run over the Dakota Division, which has not been worked during the winter, and trains will soon begin running regularly through to Bismarck.

New York & New England.

An increase of local train service has been made both on the main line and the Woonsocket Division. The Readville shops have recently turned out a number of cars built expressly for the transportation of fruit.

Allegheny Valley—Eastern Extension.

The last spike was driven, March 23, near Tyler's, Clearfield County, Pa., by Mr. John A. Wilson, Chief Engineer. Several appropriate speeches were made on the occasion, and the tracklayer, Mr. J. L. Murphy, was complimented for the smoothness of his newly-laid track.

It is expected that the line will be opened for traffic May 1.

Jersey Shore, Pine Creek & Buffalo.

The heavy rock cutting along the West Branch Canal is nearly completed. Work is to be resumed this Spring on the grading near Port Allegheny, Pa., where considerable work has already been done.

Northampton & Shelburne Falls.

Surveys are being made for this road which is to extend from Northampton, Mass., north by west to Shelburne Falls on the Troy & Greenfield road, a distance of about 25 miles.

Toledo, Peoria & Warsaw.

The United States Circuit Court has made an order directing that all surplus earnings after deducting current expenses shall be used in paying wages due to employes for December and January last. It also ordered that no other debts be paid until all debts for labor are fully discharged. This order was made apparently at the instance of the officers of the road, who desired to avoid trouble with the employes. The latter hold several meetings and appointed committees to see what steps could be taken to secure their back pay. The order of the Court gave general satisfaction to the men.

Emigrant Rates Westward.

The competition between the three trunk lines still continues, and the New York Central & Hudson River made a further reduction in rates, and was followed by the Erie and Pennsylvania. The rate from New York to Chicago is now $5, with other points in proportion.

Texas & Pacific.

Mr. Isaac H. Sturgeon, the Government Commissioner to examine and report on the Texas & Pacific road, has reported to the Interior Department that he has found all the lines completed to be in good condition and recommends their acceptance.

The Boston & Maine and Eastern Controversy.

The agreement between these companies was finally signed April 4. The contract provides that an executive committee of three from each board shall take charge of all competing business at the stations of Somerville, Malden, Danvers, Lawrence, Newburyport, Great Falls, Dover, Salmon Falls, Rochester, Wolfeborough, North Berwick, South Berwick, Saco, Biddeford and Portland. Sixty per cent. of all receipts on each road will be reserved by the roads receiving them, and the balance of forty per cent. will be placed in a fund, to be equally divided between the roads. The agreement takes effect May 1, and the changes in running trains and other minor affairs will take place a month later.

Ogdensburg & Lake Champlain.

A new suit has been brought by the company to test the validity of the agreement under which the road has been operated by the Central Vermont trustees, and the Central Vermont Company.

Dividends.

The following dividends have been declared:

Central Railroad Company of New Jersey, quarterly, 2½ per cent., payable April 20. Transfer books are closed from April 6 to April 15.

Lehigh Valley Railroad Company, quarterly, 2¼ per cent., payable to women April 14; to others, April 15.

Meetings.

The annual meeting of the Lake Shore & Michigan Southern Railway Company will be held in Cleveland, O., May 6.

A Lofty Railroad.

A correspondent of the South Pacific *Times*, of Callao, Peru, writing from Tacna, says:

"According to notices I have received, the railroad to the Bolivian frontier is in a very forward state. The engineers, Don Edward Manby and Don George Von Grumbkow, began their operations in Huasillo de Potosi at a height of 14,000 feet above the level of the sea. The road will be a narrow gauge of three feet, engines by Fairlie, and with a minimum curve of 350 feet radius, the greatest gradient to be 4 per cent. The line passes by Tarapampa near la Portida; by Chalpapalca and Palca, where it follows the curve of the valley to San Francisco and Pachia. As the line is to be a narrow one it will not be so difficult to make as might at first sight appear. There are no tunnels."

ANNUAL REPORTS.

Central of New Jersey.

The report for the year 1873 includes the operations of the branches owned, and of the Lehigh & Susquehanna Railroad and branches leased, the whole 180 miles of main line and 112⅛ miles of branches being operated as one concern. The Lehigh equipment is included in the general statement of equipment, which also includes that of all the branches; and the repairs of the same are included in the general expense account.

SERVICE OF THE ROAD.

The service of the whole road, as compared with that of the previous year, has been as follows:

	1873.	1872.	Inc. or Dec.
Miles run by passenger trains	1,439,117	1,398,147	40,970 Inc.
" " merchandise trains	1,116,750	1 060 742	56,008 "
" " coal trains	2,445,611	2,142,348	303,263 "
Total by transportation trains	5,001,478	4,601,237	401,241 "
Miles run by wood, gravel and construction trains	265,247	288,654	23,407 Dec.
Total miles run by trains	5,266,725	4,889,891	376,834 Inc.

PASSENGERS, FREIGHT AND COAL.

A comparison of the passenger business of the year 1873 with the previous year gives the following results:

	1873.	1872.	Decrease.
Number of passengers	4,401,326	4,478,513	77,187
Miles traveled by passengers	48,448,769	49,272,020	823,251

No account is here taken of the commuters, 2,500 in number, or the free passengers. The falling off in the number and mileage of passengers, while the receipts have increased, is owing to the fact that monthly tickets have been introduced, of which large numbers have availed themselves.

A similar comparison of merchandise business gives as follows:

	1873.	1872.	Decrease.
Number of tons carried	1,440,580	1,490,580	50,100
Tons carried one mile	85,725,370	88,560,282	2,834,912

In this case also, though there is a reduction in tonnage and mileage, there is an increase in receipts. This is explained by a large falling off in freight on which little was made, which was more than counterbalanced by an increase in more profitable freight.

A similar comparison of the coal business gives the following results:

	1873.	1872.	Increase.
Number of tons carried	3,906,315	3,619,549	286,766
Tons carried one mile	335,717,780	294,376,287	41,341,493

Of this coal an ever-increasing proportion is from the coal properties in which this company holds a large interest.

The total coal tonnage over the Central Division, since transportation of coal was commenced, 18 years, has been 10,978,387 of Lehigh and 10,799,898 of Lackawanna, or 21,778,285 in all. In 1873 there was an increase in Lehigh coal of 458,281 tons, and a decrease in Lackawanna coal of 204,166 tons, on the Central Division.

EQUIPMENT.

The company now owns 241 engines, of which 233 burn hard coal and 8 wood. During the year 2 passenger, 12 freight and 2 shifting engines have been added. One engine has been condemned as unfit for service.

The equipment of cars consists of a total of 176 passenger-train cars, 16,294 freight-train cars and 447 road and service cars—14,696, chiefly coal cars, being 4-wheel cars. During the year additions were made as follows: purchased, 2 passenger, 50 6-wheel iron and 270 4-wheel coal cars; built in company's shops, 50 box, 12 work-train flat, 1 iron and 2 4-wheel coal cars. The changes made were: 2 first-class passenger changed to combination cars; 1 first-class and 1 second-class passenger, 6 6-wheel iron and lime, 142 8-wheel coal, 1 6-wheel wood rack and 1 8-wheel flat car broken up or destroyed.

TRANSPORTATION ACCOUNT.

The following is a statement of the ordinary receipts and expenses of both roads for the year 1873, compared with 1872:

RECEIPTS.

	1873.	1872.	Inc. or Dec.
Passengers	$1,409,044 21	$1,391,209 29	$17,834 92 Inc.
Merchandise	1,920,102 76	1,894,640 84	25,461 92 Inc.
Coal	5,462,863 05	3,718,236 90	1,744,626 15 Inc.
Mail	29,015 00	19,499 95	9,515 05 Inc.
Express	26,114 50	26,417 16	302 66 Dec.
Rents	21,927 99	19,618 90	2,309 09 Inc.
Miscellaneous	18,298 47	17,771 70	526 77 Inc.
Car service	.....	33,323 25	33,323 25 Dec.
Total receipts	$8,881,365 98	$7,120,717 99	$1,760,647 99 Inc.
Expenses	4,215,584 20	4,236,806 31	21,222 11 Dec.
Balance net earn'gs.	$4,665,781 78	$2,883,911 68	$1,781,870 10 Inc.

The gross receipts per mile run have been as follows: From passenger trains 98 cents against $1 in 1872; from merchandise trains, $1.72 against $1.79; from coal trains, $2.23 against $1.74. The average receipts per mile run from all trains have been $1.69 against $1.46 the previous year. The gross expenses per mile run have been 80 cents against 87 cents the previous year, showing a steady increase in the economy with which the road has been operated.

The gross receipts were $30,364, and the net receipts $15,951 per mile of road worked.

The capital account has been increased by the issue of $1,887,700 convertible bonds of 1902, and the assumption of $600,000 Newark & New York bonds.

The profit and loss account stands as follows:

Gross earnings during the year		$8,881,365 98
It has been debited as follows:		
Ordinary expenses	$4,215,584 20	
Rent of Lehigh & Susquehanna Railroad	1,150,303 63	
Interest account	868,658 71	
State taxes	69,496 03	
Dividend account	1,600,000 00	
		$7,904,042 57
Balance to credit of account		$977,323 41

Of this surplus $270,895.21 has been applied to the reduction of the valuations of equipment and other accounts, and $34,917.75 to making good the deficiency of last year, leaving $671,510.45 remaining as undivided profits.

BUSINESS OF THE YEAR.

The gross receipts for the year 1873 show a handsome increase over those of 1872, while the expenses of operation and maintenance show a slight decrease. These results are due to the increased tonnage at increased tolls, and higher prices received for coal, the more steady and regular movement of tonnage, the largely improved condition of the tracks, engines and cars, the general freedom from serious accidents, and to the interest manifested by all the officers and employes in

LOCOMOTIVE RETURNS, OCTOBER, 1873.

NAME OF ROAD.	Number of miles operated	Number of Locomotives in service	Mileage	No. Miles run to: Ton of Coal	Cord of Wood	Pint of Oil	Average No. of Freight Cars Hauled	Cost per Mile in Cents for: Repairs	Fuel	Stores	Miscellaneous	Engineers, firemen and wipers	Total	Average cost of: Coal, per ton	Wood, per cord
Atlantic & Great Western (First & Second Div.)	228	80	218,785	41.12		14.38		5.77	7.25	0.67	0.73	6.67	21.09	$2.84	$3.68
" " (Third & Fourth Div.)	203	50	112,309	41.12		15.09		5.25	7.25	0.64	0.92	6.20	20.26	2.84	3.68
" " (Mahoning Division)	113	60	168,556	41.12		17.94		2.99	7.25	0.50	0.51	6.24	17.49	2.84	3.68
Atchison & Nebraska		10	27,430	56.70		22.20		1.74	9.09	0.38		7.32	18.53	5.00	3.00
California Pacific	148	12	32,867	40.24	83.38	23.18		2.51	18.25	0.58		6.96	28.30	8.25	6.00
Central Pacific (Western Division)	173.4	42	116,461	43.95		14.19		7.39	17.55	0.92		7.97	33.83	7.68	4.50
" " (Sacramento Division)	119.5	36	84,702		27.81	15.18		7.85	16.18	0.86		8.59	33.50		4.50
" " (Truckee Division)	204.5	26	67,845	34.50	50.13	18.11		4.46	20.25	0.67		8.23	33.61	7.68	4.50
" " (Humboldt Division)	236.6	22	60,148	40.68		16.82		5.52	18.74	0.69		7.65	32 60	7.68	4.50
" " (Salt Lake Division)	182.8	24	64,041	36.12		14.47		9.61	21.11	0.84		7.98	39.54	7.68	4.50
" " (Oregon Division)	151.48	8	21,000		40.70	16.41		5.94	11.06	0.76		7.81	25.57		4.50
" " (Visalia Division)	146.3	9	19,985	64.80		20.52		5.87	11.84	0.64		8.51	26.56	7.68	4.50
Chicago & Northwestern (Wis. & Mil. Div.)		91	229,304	31.05				7.35	12.73	0.98		8.35	29.41	3. 0	4.75
" " (Madison Division)		22	70,626	38.94				4.19	9.75	0.83		6.83	21.50	3.50	4.75
" " (Galena Division)		83	223,722	30.61				6.59	11.66	0.97		9.08	28.30	3.50	4.75
" " (Iowa Division)		71	185,408	26.11				4.71	13.80	0.83		8.74	28.08	3.50	4.75
" " (Peninsula Division)		34	95,304	36.64				4.12	13.01	0.72		8.28	26.13	3.50	4.75
" " (W. & St. Peter lines)		30	82,592	33.00				4.29	15.06	0.99		8.02	28.36	3.50	4.75
Chicago, Rock Island & Pacific (Illinois Div.)		84	191,794	36.16		16.17		4.12	7.85	0.56		6.85	19.3*	2.75	4.00
" " (Iowa Division)		110	292,184	34.05		14.46		4.58	8.34	0.59		6.88	20.39	2.75	4.00
Cleve., Col., Cin. & Ind. (Indianapolis Div.)	207	61	187,842	40.80		23.95		4.83	7.03	0.58		7.55	19.99	2.87	
" " " (Columbus Div.)	138	57	156,949	45.66		25.00		2.50	7.23	0.63		7.32	17.68	3.30	
" " " (Cincinnati Div.)	130	26	71,774	41.23		25.89		2.16	6.57	0.53		8.19	17.45	2.71	
Cleveland & Pittsburgh															
Del., Lacka. & West. (Bloomsburg Div.)	86	25	64,535			30.60		4.36		0.79		5.33	10.08		
Denver Pacific		6	17,328	5°.2o		14.81		0.90	5.64	0.49		6.89	13.92	3.25	5.13
Illinois Central (Chicago Division)	262.50	66	163,720	38.86		14.41	18.55	9.81	5.13	0.45		6.76	22.15	1.90	3.70
" " (South Division)	250.75	30	83,920	34.01		13.22	17.81	2.08	5.79	0.52		6.56	20.95	1.90	3.70
" " (North Division)	225	45	128,076	29.34		12.14	16.73	7.26	6.78	0.55		6.60	21.19	1.90	3.70
" " (Iowa Division)	401	44	127,466	33.60		15.93	13.12	4.32	7.10	0.45		6.33	18.20	2.25	7.50
Indianapolis, Bloomington & Western		66	201,315			13.25		3.47	7.14	0.77		7.82	19.20	2.01	3.12
Kansas Pacific		88	210,721	36.13		11.17		6.36	10.64	0.64		7.20	24.84	3.75	4.39
Lake Shore & Michigan South. (Buffalo Div.)*		85	225,903	52.33	22.04	13.90		6.13	7.02			6.01	19.16	3.50	3.50
" " (Erie Div.*		99	286,875	50.36	46.13	23.43		4.10	7.02			6.61	17.73	3.50	4.00
" " (Toledo Div.)*		74	214,475	50.28	50.16	13.63		3.90	7.96			7.12	18.98	4.00	4.00
" " (Mich.South. Div.)*			590,594	46.13	57.06	19.56		4.11	7.63			6.58	18.32	4.50	3.50
														per bu.	
Louisville & Nashville (Main System)	356	85	168,745	40.04		14.74		4.83	9.71	0.56	1.88	9.04	26.02	0.126	3.15
" " (Clarksville Div.)	128.4	13	23,328	25.20		14.53		5.45	9.93	0.67	3.49	9.28	28.82	0.147	3.33
" " (Memphis Division)	130.4	19	37,076		33 71	11.44		5.45	9.93	0.67	3.49	9.28	28.82	0.147	3.33
" " (Nash. & Decatur Div.)	122	23	38,901	41.72		18.27		12.39	11.23	0.54	3.53	7.56	35.25	0.142	3.65
" " (S. & N. Alabama Div.)	183	29	37,035	44.80		14.40		9.09	8.13	0.62	5.67	10.01	33.52	0.125	2.25
														per ton.	
Leavenworth, Lawrence & Galveston	206.6	15	42,000	69.25		34.23		4.78	6.60	0.41		6.65	17.84	4.00	2.50
Marquette, Houghton & Ontonagon†		28	63,479	53.41		16.32	45.47	4.91	13.02	1.32	2.52	7.37	29.14	7.00	2.00
														per bu.	
Pennsylvania (New York Division)	119.9	116	291,771	50.10	54.95	10.55		3.90	9.90	1.30			15.10	0.16	6.96
" (Amboy Division)	142.2	63	117,719	71.04	53.19	12.72		5.10	7.80	1.00			13.90	0.16	6.96
" (Belvidere Division)	84.6	41	75,826	59.20	35.97	11.52		2.50	10.50	1.30			14.30	0.16	6.96
" (Philadelphia Division)	204.3	164	454,969	30.86		14.16		1.80	6.70	0.90			9.40	0.07	3.28
" (Middle Division)	131.6	136	402,788	29.06		19.65		2.80	7.00	0.70			10.50	0.07	3.28
" (Pittsburgh Division, East End)		89	194,158	23.22		10.12		2.80	8.80	1.20			12.80	0.07	3. 8
" (Pittsburgh Division, West End)		129	299,208	52.88		13.12		3.90	6.20	0.90			11.00	0.07	3.28
" (Tyrone Division)	100.3	30	52,983	26.74		22.94		2.10	7.70	0.80			10.60	0.07	3.28
" (West Pennsylvania Division	103.6	33	77,059	33.13		22.03		3.20	6.20	0.40			10.00	0.07	3.28
" (Lewistown Division)	62.5	11	20,659	41.66		20.08		2.90	5.10	0.80			8.80	0 07	3.29
" (Bedford Division)	45	10	17,405	51.15		21.64		1.90	4.10	0.80			6.70	0.07	3.29
														per ton.	
Pitts., Fort Wayne & Chicago (Eastern Div.)	468.9	173	468,060	38.60		13.74		3.07	7.21	0.58	0.96	6.97	18.79		
" " " (Western Div.)	280	108	289,223	44.80	24.09	16.45	20.30	3.20	8 00	0.60		7.10	18.90	3.00	3.25
Pitts., Cin. & St. Louis (Little Miami Div.)		39	108,963	40.50		11.55		3.50	7.10	0.90	3.00	8.00	22.50	2.25	3.40
South Carolina		38	81,805	38.09		29.94		6.81	7.06	0.76			14.63		2.69
Southern Pacific, of California	165.1	19	49,071	51.91	92.05	14.55		7.48	18.65	0.99		7.29	34.41	9.50	6.75

* Switching engines allowed 6 miles per hour. † 0.35 lbs. sand used per mile run.

maintaining the discipline of the road, and in watching and protecting the interests of the company.

The expenses of maintenance and operation for 1873 have been 47 per cent. of the receipts, or 3 per cent. less than the Superintendent's estimate. If the calculations for the business of the current year are correct, this can be reduced to 45 per cent. and continue the improvement of the tracks and equipment.

CONSOLIDATIONS.

Under authority of the stockholders the Newark & New York Branch, 6.22 miles, and the Elizabethport & Perth Amboy Branch, 11.81 miles, have been consolidated with the main line. The stock of these two companies having been almost entirely held by the Central, the change was really nominal, but simplifies the accounts.

NEW YORK & LONG BRANCH RAILROAD.

The controversy with the lessees of the Delaware & Raritan Canal in relation to the Raritan River Bridge has been amicably settled, the New York & Long Branch Company agreeing to enlarge the draw to clear openings of 200 feet and the Pennsylvania Railroad Company to pay $100,000 towards the expense of the change, but without receiving any interest in the bridge.

Under an agreement of lease to the Central work has been commenced on the road at several points, and will be pushed as fast as money comes in; but there is little prospect of the road being completed the present season. The rails have been laid on the Perth Amboy Branch, from Elizabethport to within a short distance of the place.

RIPARIAN RIGHTS.

After long negotiations, an agreement was made in the fall with Riparian Commissioners of the State of New Jersey for a full settlement of all controversies and suits concerning riparian rights to lands under water south of Jersey City by the payment of $300,000. For that sum this company and the American Dock and Improvement Company settled the title to the lands under water for 2¼ miles on New York Bay.

LEHIGH & WILKESBARRE COAL CO.

During the year various consolidations of coal interests have been effected by which all the properties of the Wilkesbarre Coal & Iron and the Honey Brook Coal Companies were vested in the Broad Top Mining Company under a favorable charter, the new organization taking the name of the Lehigh & Wilkesbarre Coal Company. The new company has also acquired by purchase or perpetual lease all the coal properties of the Lehigh Coal & Navigation Company. Its properties have been carefully selected, and lie together in solid bodies requiring the least amount of lateral roads to reach them. The total area of lands is 42,328 acres, of which 21,725 acres are coal lands. There are on these properties 37 slopes and 13 shafts, making 50 openings in all, which supply 26 breakers. The present capacity of production is 3,100,000 tons. By October this capacity will be increased to 4,000,000 tons, which can be readily augmented to 5,000,000 tons whenever the market will take the additional amount.

In 1873 these mines sent to market 2,613,000 tons, of which 1,640,000 tons went to tide water. The estimated production for 1874 is 3,000,000 tons, of which 1,700,000 are expected to go to tide.

The total cost of the property is $17,666,412.10. A controlling interest in the stock is held by the Central Railroad Company.

LEHIGH AND DELAWARE DIVISION CANALS.

An arrangement has been made with the Lehigh Coal & Navigation Company by which the Central Company assumes the management of these canals, agreeing to pay $200,000 for the revenue of the Lehigh Canal and to assume the payments required by the lease of the Delaware Division Canal, amounting to $188,701.40 yearly. No great profit is expected from the canals and no loss, but it is believed to be best to control their management.

DIVIDENDS.

Semi-annual dividends of four per cent. each were made in July and January, and a surplus of $671,510.45 carried down as undivided profits.

LEASE OF THE LEHIGH RAILROAD.

The lease of the Lehigh Railroad has proved eminently successful. Not a jar has occurred in the relations of the two companies, and it is believed to have worked as well for the lessors or for the lessees.

BALANCE SHEET.

Debtor.

Total railroad owned (267 miles single track)	$12,304,616 27
Stations, shops and ferry buildings	3,284,386 74
Ferry interest and boats	624,046 10
Rolling stock	8,094,580 35
Land accounts	479,682 11
Coal and dock company stocks	6,453,169 32
Other property and materials on hand	961,885 19
Cash and accounts receivable	4,584,890 59
	$36,687,256 67

Creditor.

Capital stock	$20,000,000 00
Bonded debt for which company is responsible	12,090,803 29
Dividend due January 20	800,000 00
Interest on bonds, accrued not yet due	214,434 21
Accounts payable	2,910,508 72
Renewal fund, undivided profits	671,5.0 45
	$36,687,256 67

Cleveland, Columbus, Cincinnati & Indianapolis.

The annual report for 1873 describes the lines of the company and gives the history of the organization briefly as follows:

The Cleveland, Columbus & Cincinnati Railroad Company was chartered March 12, 1845; was completed, and trains run through from Cleveland, on Lake Erie, to Columbus, Ohio, February 22, 1851—138 miles.

In the year 1861, the Cleveland, Columbus & Cincinnati Railroad Company acquired by purchase that portion of the Springfield, Mt. Vernon & Pittsburgh Railroad between Delaware, Ohio, and Springfield, Ohio—50 miles.

The Indianapolis, Pittsburgh & Cleveland Railroad, extending from the City of Indianapolis, in the State of Indiana, eastward, to Union City, at the State line of Indiana, 84 miles, and the Bellefontaine & Indiana Railroad, extending eastward from Union City to Galion, Ohio, 119 miles, were consolidated under the name of the Bellefontaine Railway Company, in the year 1864, pursuant to the laws of the States of Ohio and Indiana.

In April, 1873, the Cleveland, Columbus & Cincinnati Railroad Company was consolidated with the Bellefontaine Railway Company, under the name of the Cleveland, Columbus, Cincinnati & Indianapolis Railway Company, pursuant to the laws of the States of Ohio and Indiana—

Making the total length of the Cleveland, Columbus Cincinnati & Indianapolis Railway 391 miles.

On the 24th day of January, 1871, the Cleveland, Columbus, Cincinnati & Indianapolis Railway Company, pursuant to the laws of the State of Ohio, became the lessees of the Cincinnati & Springfield Railway, extending from the city of Cincinnati, Ohio, northward to the city of Springfield, Ohio, 80⅛ miles.

Total length of road owned and operated by the Cleveland, Columbus, Cincinnati & Indianapolis Railway Company, 471½ miles.

The equipment at the close of the two years was:

	1873.	1872.	Inc. or Dec)
Locomotives	130	118	12 Inc.
Box cars	1,938	1,711	227 Inc.
Stock cars	235	239	4 Dec.
Flat cars	524	493	31 Inc.
Coal cars	579	580	1 Dec.
Total freight-train cars	3,406	3,141	265 Inc.
Passenger-train cars	71	64	7 Inc.

All the new locomotives are coal-burners and 16 old ones were changed into coal-burners, leaving but 16 wood-burners on the road.

The expenditures for new construction and equipment were $701,643.07 during the year, $408,818.56 of which was for new rolling stock.

This property is represented by the following capital account:

DEBTOR.

Construction and equipment	$17,097,222 22
Materials on hand	398,709 55
Bills and accounts receivable and cash	477,061 08
Stocks and bonds of other companies (cost)	1,627,378 63
Cincinnati & Springfield Railway advances	469,634 72
Indianapolis & St. Louis trustees	73,998 40
Sundry real estate not used for railroad	46,642 34
Total	$20,190,646 94

CREDITOR.

Capital stock	$15,000,000	
Less held by company	8,350	
		$14,991,650 00
Bonded debt		3,429,000 00
Unpaid dividends, bills payable and bills audited		876,606 75
Surplus		893,390 19
		$20,190,646 94

This stock is at the rate of $38,342 per mile of road owned. The bonded debt is at the rate of $8,770 per mile owned; but the cost of the stocks and bonds owned by the company is nearly half as much.

The average mileage worked was 430 in 1872 and 471¼ in 1873, the increase being about 10 per cent.

The work done for the two years was as follows:

	1873.	1872.
Passenger-train mileage	694,735	644,307
Freight-train mileage	3,489,353	2,986,590
Service-train mileage	166,480	246,.60
Total	4,350,568	3,877,157
Increase 1873 (11 per cent.)		473,411
	1873.	1872.
Passengers carried	513,624	512,396
Passengers carried one mile	27,623,254	27,518,395
Tons of freight carried	1,680,588	1,444,354
Tons of freight carried one mile	274,310,194	256,313,274

The increase in passenger mileage is less than 0.4 per cent., of freight mileage a trifle more than 7 per cent., effected with an increase of 11 per cent. in engine mileage.

The receipts and expenses were:

EARNINGS.

	1872.	1873.
From freight	$3,439,999 91	$3,735,894 81
From passengers	8 6,708 64	831,272 23
From mail	76,295 75	86,401 15
From express	76,650 28	83,032 10
From rents	58,970 75	60,385 11
From interest and dividends	74,462 98	90,463 39
From other sources	36,082 54	
Total earnings	$4,573,170 85	$4,887,448 89
Increase (6.85 per cent.)		314,277 .4
Working expenses	$3,193,644 84	$3,423 398 13
Increase (7.22 per cent.)		229,753 29
Percentage of working expenses to receipts	69.8	70.4
Taxes	127,934 54	127,018 42
Interest on bonds	199,631 28	229,393 36
Available surplus	1,051,960 19	1,107,638 68
Increase 5¼ per cent.)		55,678 49

Boston & Lowell.

This company and the Lowell & Nashua operate together a main line from Boston to Nashua, N. H., 40 miles; the Mystic River Branch, 2 miles; the Lexington Branch, 16 miles; the Woburn Branch, 2 miles; the Stoneham Branch, 3 miles; the Lowell & Lawrence road, 13 miles; the Salem & Lowell road, 20 miles; the Stony Brook Railroad, 13 miles; the Wilton Railroad, 15 miles; and the Peterborough Railroad, 11 miles, making in all 135 miles of road. The whole is worked under one management, and the receipts are divided in the proportion of 69 per cent. to the Boston & Lowell and 31 per cent. to the Lowell & Nashua Company.

The report of the Boston & Lowell gives the following figures for the year ending September 30:

The earnings were:	1873.	1872.
Passengers	$582,622 46	$553,590 69
Freight	753,878 63	712,452 63
Mail	6,405 96	6,593 46
Express	21,537 42	21,334 09
Total earnings	$1,420,314 47	$1,293,969 67
Operating expenses, rents and taxes	1,077,825 58	1,052,953 38
Net earnings	$342,488 89	$241,016 29
Interest	123,086 48	
Dividends, 8 per cent	209,920 00	
Balance to contingent fund	9,482 41	
	$342,488 89	

The increase in gross earnings was 9¾ per cent.: in expenses, 2¾ per cent.; and in net earnings, 42½ per cent. The expenses were 75.88 per cent. of earnings in 1873, and 81.37 per cent. in 1872.

The work of the year was as follows:

Passenger-train mileage	403,612
Freight-train mileage	422,619
Passengers carried	1,657,774
Passenger mileage	26,662,222
Tons of freight carried	605,617
Tonnage mileage	16,681,440

The average rate per ton per mile was 3.80 cents; per passenger per mile, excluding season tickets, 2.746 cents; including season tickets, 2.3 cents.

The equipment includes 40 locomotives, 62 passenger-train cars and 953 freight-train cars. Ten engines and 32 cars are equipped with the Smith vacuum brake.

During the year the Lexington Branch was extended from Lexington to Concord, eight miles, and opened for business in August. The Mystic River Branch was completed and put in operation and the wharf completed and graded. The great new passenger depot in Boston was completed. The Peterborough Railroad was nearly completed during the year and has been opened since its close.

There has been during the year an increase of $140,000 in stock, $277,000 in bonds and $120,276.26 in outstanding notes. The proceeds have been expended on the Mystic River Branch,

in improving terminal facilities in Boston and on other new construction and equipment.

The capital account now stands as follows:

Stock	$2,993,000
Funded debt	1,199,500
Floating debt, notes payable	968,800
Total (excluding current balances, etc.)	$5,161,300

In addition to the 42¾ miles of road owned, this represents an investment in branch lines (leased) and outside property of $3,283,410.85.

Camden & Atlantic.

This company owns a line 60 miles long from Camden, N. J., southeast to Atlantic City, and it leases the May's Landing Railroad, from Egg Harbor City south to May's Landing, 7 miles.

The operations for the year 1873 were as follows:

Receipts from:	
Passengers	$308,429 50
Freight	129,394 86
Express	21,610 03
Ferry from Camden to Philadelphia	41,804 86
May's Landing Railroad	3,799 28
Mails	3,000 00
Other sources	957 50
Total earnings ($7,597 per mile)	$508,996 03
Expenses:	
Running account	$70,374 47
Repairs and renewals of road	85,577 09
Repairs of equipment	43,285 85
General and miscellaneous expenses	58,653 63
Ferry expenses	30,904 39
May's Landing road, expenses and rent	9,613 29
Total expenses (58.63 per cent.)	$298,408 72
Net earnings ($3,143 per mile)	$210,587 31

The increase in gross receipts over 1872 was $41,960, or 9 per cent.

The business of the year was as follows:

	1873.	1872.
Through passengers	93,858	— 78,526
Excursion passengers	67,648	— 67,090¼
Way passengers	302,202¼	—271,569¾
Total passengers carried	463,708¼	—417,186
Total freight carried	104,540¾	— 69,324¼
Mileage of engines	216,246	—204,790
Receipts per mile run	$2.14	— $2.08
Expenses per mile run	1.0632	— 0.9722

The equipment consists of 10 engines, 27 first-class and 25 second-class passenger, 5 baggage, 2 mail and 2 smoking cars; 46 box, 58 flat, 7 lime cars and 3 timber trucks; one wreck car. Four parlor cars belonging to the Woodruff Sleeping-Car Company are on the road. Two locomotives, 8 first-class passenger and 12 freight cars have been added during the year.

During the year 400 tons of new rails have been put in the track and 883 tons old rails cut and relaid. Of the old rails 11,048 feet were used on sidings and 2,600 feet in extending the May's Landing road to the river. The expenditures for new construction during the year were $6,540.78; new equipment, $82,497.29; real estate, $45,077.50; land damages, $597.

Interest payments on bonded debt amounted to $74,525.50, and dividends on preferred stock to $28,106.75.

The capital account at the close of the year was as follows:

Common stock	$377,400 00
Preferred stock and scrip ($619.58)	838,469 58
Total stock ($20,265 per mile)	$1,215,869 58
First-mortgage bonds	490,000 00
Second-mortgage bonds	500,000 00
Total bonded debt ($16,500 per mile)	$990,000 00
Floating debt, less assets	111,311 30

There has been no change except an increase of $70,939.66 in the floating debt. The annual interest charge is $69,300, or $1,155 per mile.

[Entered according to Act of Congress, in the year 1874, by the RAILROAD GAZETTE, in the office of the Librarian of Congress, at Washington.]

THE CATECHISM OF THE LOCOMOTIVE.

BY M. N. FORNEY, *Mechanical Engineer.*

PART VIII—(CONTINUED).

THE BOILER ATTACHMENTS.

QUESTION 139.—*How can the height of the water in the boiler be known?*

Answer. Two appliances are used by which the height of the water in the boiler can be observed. These are: 1. *Gauge or try cocks.* 2. The *glass water gauge.*

Every locomotive is provided with four or more gauge-cocks, which are usually placed at the back end of the boiler, where they can easily be seen and reached. These cocks *S, S, S, S,* are shown in fig. 71, which represents the back end of a locomotive, and to which frequent reference will be made. They are also shown on a larger scale in fig. 72, which represent the end plate of the boiler in section. They communicate with the inside of the boiler and are so placed that one is three or four inches above the other. The two upper cocks are placed above the point where the surface of the water should be when the engine is working, and the two lower ones below it, so that the upper ones communicate with the steam space and the lower ones with the water. When these cocks are opened, if the water is at its proper height, steam is discharged from the two upper ones, and water from the two lower ones.

When a gauge-cock which communicates with the steam space is first opened, it is usually filled with condensed water, so that it should usually be kept open for a little while until this water is discharged. If the upper cocks are opened and continue to discharge *water,* they indicate that there is *too much* water in the boiler; on the other hand, if steam is discharged when the lower cocks are opened, then there is too little water in the boiler, and the heating surface is in danger of being exposed to the fire without being covered with water, and consequently overheated, or as it is called "burned," and so injured as to become too weak to bear the strain to which it is subjected by the pressure of the steam. There is therefore great danger that the crown sheet may be crushed down by the pressure of the steam above it, or that the boiler may be exploded. Even if no accident occur, the boiler is in great danger of permanent injury from overheating when the water is allowed to get too low.

Below the gauge cocks *S, S, S, S,* fig. 71, an inclined cylinder *E,* called a *drip-pipe,* is placed with openings to receive the water and steam which are discharged from the cocks. This water is conducted away by the pipe *P.*

The *water-gauge, P,* fig. 71, which is shown in section in fig. 73, consists of an upright* glass tube, *a, a,* which is from one-half to three-quarters of an inch in diameter, and from 12 to 15 inches long. The glass is about one-eighth of an inch thick. At its ends it communicates with the steam and water of the boiler through brass elbows, *b, c.* The openings in these elbows, which communicate with the boiler, are closed by the valves or plugs, *d, e,* which are worked by screws and handles, *f, g.* The glass tube, when it is attached to the elbows, is made steam-tight by rubber rings, which are pressed tight around the tube by *packing-nuts, h, i.* The elbows are provided with the valves, *d, e,* so that in case the glass tube breaks the steam and water can be shut off, so as not to escape through the elbows. The lower elbow is provided with a blow-off cock, *k,* through which any sediment or dirt which collects in the glass tube or elbows can be blown out. When the valves in the upper and lower elbows are opened the steam flows into the glass tube through the upper one, and water through the lower one, and the water assumes a position in the glass tube on a level with the surface of that in the inside of the boiler; that is, the position of the water in the boiler becomes visible in the glass tube. On account of the constant variations of the water in the boiler, the column of

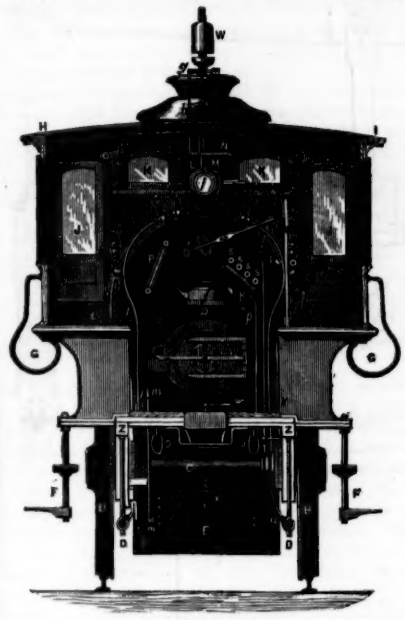

Fig. 71.

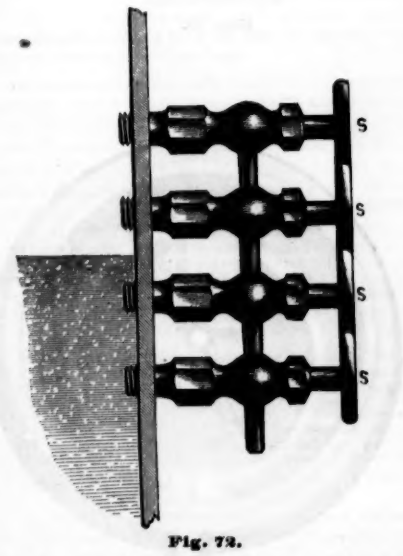

Fig. 72.

water in the glass never remains stationary, but plays up and down as long as the boiler is working. But if the communication between the glass tube and the boiler is closed, then the water in the tube becomes stationary and the water gauge is useless. In order that there may be no obstruction of the glass tube by mud or dirt from the water, it must be *blown out* often. To do this the lower valve, *e,* is closed, and the blow-off cock, *k,* and the steam valve, *d,* are opened. The steam pressure in the tube on top of the column of water will force it out of the blow-off cock, and the mud and dirt will be carried with it.

If from any cause the glass tube is broken, first of all the water-valve *e* should be closed and then the steam-valve *d,* so as to prevent the hot water and steam which will escape from the broken glass from scalding those who are working the engine. By unscrewing the nuts *h* and *i* the old glass can easily be removed and a new one substituted in its place.† Care should be taken in putting in new glasses not to screw the packing-nuts down any more than just sufficiently to make the rubber rings steam-tight around the glass tubes. If they are screwed too tight they are apt to produce a strain on the tube, so that the slightest expansion by heat or contraction from cold will break it.

* Sometimes these tubes are, for convenience, inclined, as shown in fig. 71.

† Extra glasses should always be carried with an engine so as to be substituted in case of accident to the one in use.

QUESTION 140. *How is the steam pressure in boilers prevented from exceeding a certain limit?*

Answer. By what are called *safety-valves.* These consist of circular openings, *a,* fig. 74, about three inches in diameter, placed usually at the top of the dome‡, and covered by a valve, *h,* which is pressed down either by a lever, *c, c',* and spring, *d,* as shown in fig. 74, or by a spring alone, as in fig. 76. Two of these valves are usually placed on the top of the dome, so that if one gets out of order, the other one will allow the steam to escape as soon as its pressure exceeds that which, it has been decided, the boiler can safely bear. This pressure, in locomotive boilers, is usually from 100 to 130 pounds per square inch.

If the opening for a safety-valve is three inches in diameter its area will be 7 square inches, and, therefore, if the greatest steam pressure which it is intended that the boiler shall bear is 100 lbs. per square inch, the valve must be pressed down with a pressure equivalent to $7 \times 100 = 700$ pounds. In order, therefore, to determine the amount of pressure which a safety-valve must bear, THE AREA OF THE OPENING FOR THE VALVE IN SQUARE-INCHES MUST BE MULTIPLIED BY THE GREATEST STEAM PRESSURE, IN POUNDS PER SQUARE INCH, WHICH THE BOILER IS INTENDED TO BEAR. If the pressure on the valve is produced by a lever, as in fig. 74,§ then the total weight on the safety-valve must be MULTIPLIED BY THE SHORT ARM OF THE LEVER, (or the distance *A* between the centre of the fulcrum *e* and that of the load *f*) AND DIVIDED BY *B,* THE TOTAL LENGTH OF THE LEVER. In fig. 74 the short arm of the lever is 3½ inches, and the whole length 35 inches; therefore, if the valve is to be pressed down with a pressure of 700 pounds, the pressure on the end of the lever would be calculated as follows:

$$\frac{700 \times 3\frac{1}{2}}{35} = 70 \text{ lbs.}$$

The spring, *d,* must therefore pull down on the end of the lever with a tension equal to 70 pounds. When the pressure of the spring bears directly on the valve, as shown in fig. 76, then the tension of the spring must be just equal to the pressure on the valve. This tension is produced by screwing down the nuts, *c, c.* The spring, *d,* which produces the requisite pressure on the end of the safety-valve lever, fig. 74, is arranged inside of two cylinders, *g* and *h,* which slide over or into each other like the sections of a telescope. This arrangement is called a *spring-balance.* The spring, *d,* is attached to the covered ends and draws them towards each other. The upper cylinder, *g,* is connected by a rod, *i,* to the flattened end of the lever, *c',* which has a hole drilled through it to receive the rod. The other end of the rod is screwed into the upper cylinder, *g.* This rod is sometimes arranged so that it can be either lengthened or shortened by the nut, *j.* By lengthening or shortening the distance, the tension of the spring is either diminished or increased. The lower cylinder of the spring-balance, represented in fig. 74, is attached to a lever, *m,* which is fastened to the back of the *steam-gauge, k.* This is shown more clearly by fig. 75, which represents the back of the gauge, and also the lever, *l, m,* whose fulcrum is at *m.* The spring-balance is attached to the lever at *k.* By drawing down the lever, the tension of the spring is increased, and by raising it up it is diminished. The lever is held in any desired position by the latch, *n,* and the ratchet, *r, r.* By this contrivance, which is employed on the engines built at the Grant Locomotive Works, the pressure on the valve can at once be either increased or diminished, which it is often desirable to do, especially when an engine is not at work. The spring-balance is shown in fig. 71, and is indicated by the letter *M* and the lever by *N.* Unless the pressure of the steam exceeds that on top of the valve, it will of course not be opened. As there is always danger that a safety-valve or some of its attachments may become corroded or otherwise disordered, so that it will not act promptly or with certainty, it is desirable to open it frequently, so as to be sure that it is in good working order. To do this the pressure on the valve must be reduced below that in the boiler, which can very conveniently be done with the *spring-balance* lever which has been described.

The lower cylinder of the spring-balance sometimes carries an index or pointer, *t,* fig. 74, which protrudes through a slot in the cylinder *g,* and indicates the amount of pressure of the spring on a scale marked along the slot on the outside of the cylinder. If it is desired that the safety-valve should open when the steam pressure reaches 100 or any other number of pounds per square inch, the spring balance is subjected to a tension which will bring an amount of pressure on the top of the safety-valve equal in pounds per square inch of its surface to that of the steam pressure desired.‖

There should always be some provision made, which will render it impossible to increase the steam pressure, beyond that which it has been determined that the boiler will safely bear. This is usually done by arranging one of the safety-valves with a lever, as shown in fig. 74, and the other without, like that in fig. 76. The latter is often covered and sealed or locked up, so as to be beyond the control of the locomotive runner.

The safety-valves are usually fitted into conical seats, *S, S,* figs. 74 and 76, so as to be perfectly steam-tight, and are made with wings or guides, *t, t,* the form of which is shown in the sectional plan, *A,* figs. 74 and 76, under the valve. These guides are intended to keep the valves in the proper positions in relation to their seats.

As soon as the steam pressure under the valves becomes greater than the pressure of the springs on top of them, the valves will be lifted up and the steam will escape until the pressure in the boiler is relieved. It will be seen, however, that although the surface of the valve which is exposed to the pressure of the steam is equal to the area of the opening for the valve, after it is lifted from its seat and the steam escapes

‡ One of these, *r,* is shown in fig. 44.

§ The lever is represented in the engraving with a piece broken out, in order to save room.

‖ In loading a safety-valve allowance must always be made for the weight of the lever and the valve.